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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 40824, 40897, 40935, 41024, 41040, and 41047.

40761 (AEEW-M-752) METHOD OF ESTIMATING HYDROGEN IN SOLID AND LIQUID SAMPLES BY MEANS OF NEUTRON THERMALISATION. Carter, D. H.; Sanders, J. E. (Atomic Energy Establishment, Winfrith (England)). June 1967. 12p. Dep. CFSTI. UK 2s. 6d.

The count-rate of a cadmium-covered ^{239}Pu fission chamber placed in a reactor neutron flux increases when a hydrogen-containing material is inserted due to the thermalisation of epicadmium neutrons. This effect forms the basis of a non-destructive method of estimating hydrogen in solid or liquid samples, and trial experiments to demonstrate the principles have been made. The sensitivity is such that hydrogen down to 10 ppM in a typical metal should be detected. A useful feature of the method is its very low response to elements other than hydrogen. (auth)

40762 (IS-1611 and Add.) BIBLIOGRAPHY OF 1966 MASS SPECTROSCOPY LITERATURE COMPILED BY A COMPUTER METHOD. Capellen, J.; Svec, H. J.; Sage, C. R. (Ames Lab., Iowa). July 1967. Contract W-7405-eng-82. 650p. Dep. CFSTI.

About 2800 articles of interest to mass spectroscopists are listed as a result of computer searching of 270,000 scientific articles published during 1966. The 149 papers presented at the 14th Annual Conference on Mass Spectrometry and Allied Topics, ASTM E-14, May 22–27, 1966, are also included. In addition to the bibliography, an author index and permuted title index (KWIC) are included in the report. (auth)

40763 (LA-3743) SEPARATION AND SPECTROPHOTOMETRIC MEASUREMENT OF 0.1 TO 5 ppm OF ZIRCONIUM IN PLUTONIUM. Bryan, R. G.; Waterbury, G. R. (Los Alamos Scientific Lab., N. Mex.). June 12, 1967. Contract W-7405-eng-36. 12p. Dep. CFSTI.

Zirconium in trace concentrations (0.1 to 5 ppM) in Pu was separated and determined spectrophotometrically as the Arsenazo III complex. Relative standard deviations calculated from 24 or more determinations each of 0.2, 0.5, 2.0, and 5.0 μg of Zr added to 1-g samples of plutonium are 43, 22, 6.2, and 2.7%, respectively. Two-g samples of plutonium are 43, 22, 6.2, and 2.7%, respectively. Two-g samples of plutonium can be analyzed satisfactorily for Zr by this method. Of 52 other elements (ions) investigated, Be, Fl, Ge, Hf, Mo, Ta, (Nb), Ti, and W caused interference when present in 100-mg quantities. Of these elements, only Hf and Ti interfered when the quantity was reduced to 1 mg. (auth)

40764 (NP-16882) A RAPID EMPIRICAL METHOD FOR THE SIMULTANEOUS DETERMINATION OF HYDROXYL AND ALUMINUM IN ALUMINATE AND BASIC ALUMINUM NITRATE SOLUTIONS. Moeken, H. H. Ph.; Van Neste, W. A. H. (European Company for the Chemical Processing of Irradiated Fuels, Mol (Belgium)). Mar. 1967. 14p. (ETR-201). Dep. CFSTI.

A potentiometric indicator method is described for determining the hydroxyl and aluminum concentrations in process solutions produced in irradiated fuel reprocessing. The two constituents are determined simultaneously by an acidimetric titration with sodium hydroxide solution. A recording titrator is used with a glass indicating electrode. The amounts of base corresponding to relevant points of inflexion on the titration curve are empirically related to the concentration of the two constituents. The method is easily adaptable to remote control, enables full use to be made of expensive laboratory space, and gives a quick analysis that is sufficiently precise. (auth)

40765 (NP-16883) A RAPID EMPIRICAL METHOD FOR THE SIMULTANEOUS DETERMINATION OF FREE ACID, IRON, AND URANIUM IN NITRATE SOLUTIONS. Moeken, H. H. Ph.; Van Neste, W. A. H. (European Company for the Chemical Processing of Irradiated Fuels, Mol (Belgium)). Apr. 1967. 16p. (ETR-202). Dep. CFSTI.

A potentiometric indicator method is described for determining the free acid, iron(III), and uranium(VI) concentrations in process solutions produced by reprocessing irradiated fuel. The three constituents are determined simultaneously by alkalimetric titration with sodium hydroxide solution in a potassium fluoride medium. A recording titrator with a glass indicating electrode is used. The base amounts corresponding to relevant points of inflexion on the titration curve are empirically related to the concentration of the three constituents. The method can be easily adapted to remote control, enables full use to be made of expensive laboratory space, and gives a quick analysis which is sufficiently precise. (auth)

40766 (NP-16884) A RAPID EMPIRICAL METHOD FOR THE SIMULTANEOUS DETERMINATION OF FREE ACID AND STAINLESS STEEL IN SULPHATE SOLUTIONS. Moeken, H. H. Ph.; Van Neste, W. A. H. (European Company for the Chemical Processing of Irradiated Fuels, Mol (Belgium)). May 1967. 12p. (ETR-204). Dep. CFSTI.

A potentiometric indicator method is described for determining the free acid and stainless steel concentrations in process solutions produced by reprocessing irradiated fuel. The two constituents are determined simultaneously by an alkalimetric titration with sodium hydroxide solution in a potassium fluoride–potassium iodide medium. A recording titrator with a glass indicating electrode is used. The base amounts corresponding to relevant points of inflexion on the titration curve are empirically related to the concentration of the two constituents. The method can be easily adapted to remote control, enables full use to be made of expensive laboratory space, and gives a quick analysis which is sufficiently precise. (auth)

40767 (EUR-3480.f(Vol.1)) METHODES ANALYTIQUES MISES AU POINT DANS LE CADRE DE LA RECUPERATION DES PRODUITS DE FISSION. PREMIERE PARTIE. ANALYSE DE SOLUTIONS DE PRODUITS DE FISSION. (Analytical Methods Developed in the Course of Fission Product Recovery. Part I. Analysis of Fission-Product Solutions). Azoeuf, P.; Guillon, A.; Lefevre, J. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). July 6, 1967. 84p. (In French). Dep.

The analytic methods adapted or developed for fission product analysis are described and their history recapitulated. The separation techniques, which consist essentially of systematic separation by ion exchange and a series of selective separations by liquid–liquid extraction are described. A description is given of the methods for chemically assaying inactive elements and for radiometric assay on separate phases by techniques previously indicated. A complete analysis usually entails a systematic separation and a number of selective separations, which may be accompanied by certain direct determinations. (auth)

40768 (EUR-3494.e) THE DETERMINATION OF CADMIUM IN CADMIUM-TIN ALLOYS. An Oscillo-Polarographic Method. Verdingh, V.; Cuyvers, H. (European Atomic Energy Community, Geel (Belgium). Central Nuclear Measurements Bureau). May 23, 1967. 11p. Dep.

A simple polarographic method that allows determination of Cd in Cd-Sn alloys is described. Sn is removed by treatment of the Cd-Sn solution with a mixture of HBr-Br_2. Small amounts of Sn reduce the height of the Cd peak. Knowing the Sn peak height a correction can be applied. 1N HCl was chosen as an indifferent electrolyte. The coefficient of variation of the method is less than 1%. (auth)

40769 (EUR-3601.f) DETERMINATION PRECISE DE L'URANIUM PAR COULOMETRIE A POTENTIEL CONTROLE. APPLICATION AUX CAS DES SOLUTIONS D'URANIUM ET D'URANIUM-ALUMINIUM. (Precise Determination of Uranium by a Potential Control of Coulometry for Uranium and Uranium-Aluminium Solutions). Le Duigou, Y.; Lauer, K. F. (European Atomic Energy Community, Geel (Belgium). Central Nuclear Measurements Bureau). June 26, 1967. 26p. (In French). Dep.

The uranium content of solutions was determined by controlled potential coulometry with a standard deviation of 0.05% for a number of measurements higher than 10. The amount of U taken for each measurement was about 25 mg. The introduction of a correction corresponding to the current intensity at the end of reduction and time of the measurement, improved this precision by a factor of two. The same method applied to aluminum-uranium alloys containing about 24% U gave a standard deviation of 0.05% on the U content. (auth)

40770 (EUR-3603.f) DETERMINATION DU TAUX DE COMBUSTION PAR L'ANALYSE RADIOCHIMIQUE DU ^{137}Cs. (Determination of Burn-Up by Radiochemical Analysis of ^{137}Cs). Terzaghi, A.; Ketels, J.; Van Hoof, E. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). June 23, 1967. 18p. (In French). Dep.

In the Hot Laboratories of GEX (Operating Group for the BR.2 Reactor and Associated Installations) the burnup determination in low enrichment UO_2 and UO_2-PuO_2 fuels is based on ^{137}Cs radiochemical analysis. The radiochemical method that has been chosen and its application for the analysis of fuels with different plutonium content are described. The results obtained by the radiochemical analysis and the gamma spectrometry of fuel solutions using a Ge-Li detector were compared. The accuracy of the parameters involved in the burnup calculation has been estimated. (auth)

40771 (HW-64619) A SEQUENTIAL SEPARATION OF THE RADIONUCLIDES OF YTTRIUM, CERIUM, AND PROMETHIUM WITH DI(2-ETHYLHEXYL)ORTHOPHOSPHORIC ACID. Campbell, M. H. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Apr. 20, 1960. Contract AT(45-1)-1350. 14p. Dep. CFSTI.

Separation of Y, Ce, and Pm by solvent extraction using the bis(2-ethylhexyl) ester of orthophosphoric acid was studied to determine the effect of nitric acid concentration. Decontamination factors for major fission product isotopes are listed. Quantitative yields based on the distribution ratios were calculated for the analytical procedure. (M.C.G.)

40772 (IS-1600, Paper 3) CHEMISTRY DIVISION. Spedding, F. H.; Hansen, R. S.; Banks, C. V.; (and others) (Ames Lab., Iowa). 104p.

Developments are reported for studies on: reactions and properties of metal in low oxidation states; x-ray diffraction; chemistry of heavy transition metals; coordination chemistry, exchange, and substitution reactions; magnetic resonance; rare earth separations; neutron diffraction; analytical separations and operations; organic analytical reagents; analytical atomic, molecular, and mass spectroscopy; kinetics and mechanisms of inorganic reactions; thermodynamic and magnetic properties of solids; surface chemistry; thermodynamic properties of rare earth electrolytes from infinite dilution to saturation; chemical mass spectroscopy; and radiochemistry and activation analysis. (P.C.H.)

40773 DETERMINATION OF THE OXYGEN CONTENT OF ALUMINIUM BY 14 MeV-NEUTRON RADIOACTIVATION ANALYSIS. Gibbons, D. (Atomic Energy Research Establishment, Wantage, Eng.); Olive, G.; Sevier, P.; Deutschman, J. E. J. Inst. Metals, 95: 280-3(Sept.1967).

Radioactivation analysis, in which the oxygen is determined through the radioactivity induced by 14-MeV neutron bombardment, was shown to be an acceptable and rapid method for determining oxygen in aluminum and was suitable for routine application. This analytical technique was applied to several industrial problems, including the distribution of oxygen in aluminum remelt, sheet, and extrusion ingots produced by a variety of casting procedures. Furthermore, it should be possible to study the efficacy of metal filtration systems in reducing the oxygen content. The short- and long-term reproducibilities of this method of analysis are acceptable for most purposes and the standard deviation at the 25 ppM oxygen level is <3 ppM. (auth) (UK)

40774 SPECTROPHOTOMETRIC MEASUREMENTS ON THE LANTHANUM (III)-ALIZARIN-S COMPLEX. Illner, E. Z. Chem., 7: 31-2(Jan. 1967). (In German).

The complex between La(III) and alizarin S was examined. Its color is a function of pH, being at 520 nm at pH 4.6 to 4.7. The curve of extinction vs concentration is not linear, but linear portions are found between 4 and 6 mg La_2O_3/50 ml and below 1 mg La_2O_3/50 ml. In between these values, and above the larger, curvature is obtained, and color changes are observed. Directions for the procedure are given in detail. (BBB)

40775 ACTIVATION ANALYSIS OF TRACES OF THE LIGHT ELEMENTS IN HIGH PURITY MATERIALS EMPLOYING GAMMA PHOTONS AND CHARGED PARTICLES. Engelmann, Ch. (Centre d'Etudes Nucleaires, Saclay, France). Int. J. Appl. Radiat. Isotop., 18: 569-78(Aug. 1967). (In French).

Research on the determination of B, C, N, and O in concentrations $<10^{-6}$ by activation analysis is described. Irradiation facilities include a 45-MeV linear accelerator, a fixed energy cyclotron giving 44-MeV alpha particles, and a variable energy cyclotron capable of giving d, p, and ^3He particles of 3 to 30 MeV. Results concerned with improvements of methods using oxidative or reduction fusion for separation of the isotopes usually obtained by activation of the impurities (viz. ^{11}C, ^{13}N, ^{15}O) are presented, and methods are described allowing determinations to be made in a few minutes. The possibilities of the use of the different particles are discussed, and in particular the importance of choice of nuclear reactions in regard to nature of the matrix and of the impurity, and the quantity of this impurity and others present in the irradiated sample. Some specific examples are described. (UK)

40776 URANIUM CONTENT OF CHONDRITES BY THERMAL NEUTRON ACTIVATION AND DELAYED NEUTRON COUNTING. Amiel, Saadia (Soreq Nuclear Research Centre, Yavne, Israel); Gilat, Jacob; Heymann, Dieter. Geochim. Cosmochim. Acta, 31: 1499-1503(Sept. 1967).

Thermal neutron activation followed by delayed neutron counting was applied to the determination of the uranium content of fourteen chondrites. The analysis was performed nondestructively and concentrations in the range of 10 to 30 ppB were measured with a precision of ~10%. (auth) (UK)

40777 USE OF γ-PHOTONS AND CHARGED PARTICLES FOR DETERMINING VERY LOW TRACES OF B, C, N, AND O. Engelmann, Ch. (CEN, Saclay, France). Bull. Soc. Chim. France, No. 7, 2316-20(July 1967). (In French).

Current possibilities of using charged particles and γ photons in the field of trace analysis of elements such as B, C, N, and O are reviewed from experimental data. Available irradiation methods are briefly described. Then the main useful nuclear reactions, as well as possible interference effects, are reviewed. Examples of applications are given for nondestructive analyses in various materials. Minimum measurable quantities of B, N, C, and O are reported for the procedures described. (auth)

40778 ISOTOPIC EXCHANGE UNDER ISOTHERMAL, SINGLE-STAGE CONDITIONS. Kryukov, S. N.; Soldatov, E. A. Vestn. Mosk. Univ., Ser. II Khim., No. 2, 67-70(Mar.-Apr. 1967). (In Russian).

Reliable data on the rate of evaporation and coefficient of diffusion in solid solutions were obtained by maintaining two samples of the same composition in a closed chamber. One of the samples (donor) contained a radioactive isotope; the other sample (acceptor) contained no radioactivity. After holding the samples for a time t at a fixed temperature, the activity of the acceptor I_a was proportional to Q/C_0, where Q is the amount of substance per unit area of sample in atoms/cm^2 transferred from the donor to the acceptor during the experiment, and C_0 is the initial concentration of labeled atoms in the donor in atoms/cm^3. At small time intervals I_a depends linearly on time: $Q/C_0 \approx \epsilon t$, where ϵ is the rate of evaporation in cm/sec. Thus, a plot of I_a as a function of t will give the rate of evaporation, and the vapor pressure of the substance can be calculated. The coefficient of diffusion D can be calculated from the following equation: $Q/C_0 = \epsilon t\ (1 - 8\epsilon(t/3)^{0.5}(\pi D)^{0.5})$. A number of experiments must be carried out at the same temperature to obtain ϵ and D. If thin layers are peeled electrolytically from the donor and acceptor simultaneously, the change in relative concentration can be determined directly and less data are needed to

determine the rate of evaporation and coefficient of diffusion. To test the method two silver samples were heated at 755°C. The rate of evaporation, coefficient of diffusion, and vapor pressure of silver agreed well with literature values. (TTT)

40779 DETERMINATION OF POTASSIUM AND MANGANESE IN PLANT TISSUES BY NEUTRON ACTIVATION ANALYSIS. Dieckert, J. W.; Derrick, K. S.; Davis, R. C.; Singh, J. (Texas A and M Univ., College Station). Contract AT(40-1)-3015. pp 81-93 of STI/PUB-137.

From FAO/IAEA Symposium on the Use of Isotopes in Plant Nutrition and Physiology Studies, Vienna, Austria, Sept. 5-9, 1966.

A technique is described for the determination of potassium and manganese in plant tissues by nondestructive thermal neutron activation analysis. The source of neutrons was the heterogeneous, nuclear reactor of the swimming-pool type cooled and moderated with light water, at Texas A & M University. Chemistry was not required for the preparation of the samples for neutron irradiation or counting. Samples were irradiated for periods of 10 min to 1 hr at a neutron flux of about 1.5×10^{12} n/cm^{2}s. The γ emitting radioactivity generated in the samples by neutron bombardment was measured with a γ ray spectrometer consisting of a multichannel analyzer and a shielded, thallium-activated, sodium iodide detector. The resulting complex γ ray spectra were resolved by spectrum stripping; and the quantity of potassium and manganese in the sample was estimated by the comparator method. Most of the data processing was done by computer techniques. Under the conditions of the analysis and in the energy range of interest, the complex spectra arising from the irradiated plant materials could be accounted for satisfactorily as being the sum of the contributions from ^{24}Na, ^{42}K, and ^{56}Mn. The precision of the method as measured by the coefficient of variation was routinely better than three percent for both potassium and manganese. Recovery experiments for each metal demonstrated a linear relationship between the quantity of metal added to a sample of plant material and the quantity recovered. Interfering reactions were found to be minimal. The method was used to determine the manganese and potassium content of roots, stems, leaves and cotyledons of peanut seedlings and seeds. The results of these analyses are in agreement with those made on similar tissues by other methods. Because of the sensitivity and convenience of the method, it proved feasible to analyze individual seeds or seedling parts in experiments involving large numbers of individual plants. The technique permitted the repeated analysis of the same sample when it was necessary. (auth)

40780 SPECTROPHOTOMETRIC DETERMINATION OF PRASEODYMIUM IN THE PRESENCE OF NEODYMIUM. Auer-Welsbach, H. (Univ., Vienna). Monatsh. Chem., 96: 1611-16 (1965). (In German).

Interference by the background in the determination of Pr in neodymium chloride solution was overcome by applying a correction for the concentration of Nd, with water as reference. Correction factors for the extinction at 444 nm are presented for the concentration range 0.05 to 0.4 g of Pr^{3+} per 100 ml. It was also possible to correct for the background by using as reference $NdCl_3$ solution containing a concentration of Nd exactly equal to the sum of the concentration of Pr and Nd in the sample; this procedure gave satisfactory results for extinction values up to 0.5. In each procedure only the absorption band at 444 nm was used successfully. (Analytical Abstr., Vol. 14). (auth)

40781 RAPID SOLVENT EXTRACTION AND DIRECT SPECTROPHOTOMETRIC DETERMINATION OF GOLD(III) WITH 2-THENOYLTRIFLUOROACETONE. Rangnekar, A. V.; Khopkar, S. M. (Indian Inst. of Technology, Bombay). Z. Anal. Chem., 230: 425-7(1967).

A procedure is described for the rapid spectrophotometric determination of gold at micro level based on the absorption measurement of the orange-red color of the Au(III) complex with 4,4,4-trifluoro-1-(2-thienyl)-1,3-butanedione in xylene. From 10 determinations carried out with 98 μg Au an absorbance of 0.270 ± 0.01 was obtained. The standard deviation is ±1.4%, the sensitivity 0.035 μg Au/ml. The main advantage of the method is that it permits a rapid (15 to 20 min) determination of Au in the presence of large amounts of the platinum group metals. Among the ions found to interfere with the determination are Sn, Hg, Cu, Fe, Cr, Ce, and U. (P.C.H.)

40782 RAPID ANALYSIS OF BORON IN GLASS BY PROMPT γ-RAY MEASUREMENT. Kusaka, Yuzuru; Tsuji, Haruo; Egawa, Masahiko (Konan Univ., Higashinada, Japan). Nippon Kagaku Zasshi, 88: 1006-8(Sept. 1967). (In Japanese).

Nondestructive determination of boron in glass samples by using an americium–beryllium neutron source (300 mCi) and by measuring the 0.478-MeV prompt γ ray produced in the $^{10}B(n,\alpha)^7Li$ reaction is described. An appropriate arrangement of the neutron source, a paraffin block as a neutron moderator, a lead block as a radiation shield, a lithium fluoride plate as a neutron shield, a sample container, and a prompt γ detector are proposed. The detector was a NaI scintillator (1.5" × 1") connected to a 400 channel pulse height analyzer. This method is applicable for the glass with relatively low boron content (0.5 to 6.0% as B_2O_3). The analytical error was 2 to 4%, and it takes only 15 min for one run. (auth)

40783 CATION-EXCHANGE METHOD FOR SEPARATION OF URANIUM FROM MOLYBDENUM. Feik, F.; Korkisch, J. (Univ., Vienna). Mikrochim. Acta, No. 5, 900-2(1967). (In German).

A method is described for the separation of uranium from molybdenum by means of cation exchange. After adsorption of the uranium on Dowex 50 from 90 vol % tetrahydrofuran + 10 vol % 6 N nitric acid, the molybdenum is washed out with a mixture having the same composition, and the uranium is eluted and then determined spectrophotometrically in the eluate employing the thiocyanate method. The applicability of the method for analysis of uranium minerals is shown. (auth)

40784 CONTINUOUS NUCLEAR ANALYSIS OF BULK MATERIAL. Parker, C. Varren Jr.; Martin, Troy C.; Blake, Kenneth R.; Morgan, Ira L. (Texas Nuclear Corp., Austin). Mater. Eval., 25: 214-20(Sept. 1967).

A nuclear analysis facility for the continuous analysis of bulk materials is now in operation and is being used in feasibility studies of analyzing various bulk materials by nuclear techniques. This pilot plant includes a variable-speed belt conveyor, a 1000 ft^3 storage tank, various screw conveyors to complete a closed loop system, a neutron generator, and data analysis system. The data analysis system is designed to analyze two elements each by fast-neutron inelastic scattering and fast-neutron activation analysis. An automatically controlled neutron generator maintains a constant flux by means of feedback circuitry and the use of beam-sweeping techniques on a 3 by 3 in. Ti/^{3}H target. Target lifetime without a decrease in neutron yield at a level of 10^9 n/sec is greater than 75 hr. This generator was operated for several hours completely unattended and performed satisfactorily. Data are presented on the utilization of this system in the continuous measurement of some of the major elements in coal, aluminum ore, and other bulk materials. Results of studies using a simple liquid loop consisting of small plastic tubing wrapped around a neutron generator target and a shielded gamma detector are also presented. (auth)

40785 FAST-NEUTRON ACTIVATION ANALYSIS OF SILICON IN SPUTUM. Sardi, A. (Central Research Inst. of Physics, Budapest); Tomcsanyi, A. Analyst, 92: 529-31(Aug. 1967).

A method for a relatively rapid and accurate determination of silicon in sputum by activation analysis is described. The method was developed to identify and separate the cases of silicosis from those of pulmonary tuberculosis. The sputum was digested by trypsin, then spun in a centrifuge three times at room temperature, and once after heating with 5% trichloroacetic acid to remove phosphorus, which interferes in the activity measurement. For irradiation, a neutron generator with a fast-neutron yield of 2×10^9 n per cm^2 per second was used. After exposing for 2 to 3 minutes and then waiting for 1 minute the activity measurements are made using a multi-channel analyser for 4 to 6 minutes. The silicon content was evaluated from the aluminium-28 activity produced by the reaction $^{28}Si(n,p)^{28}Al$ with a photopeak at 1.78 MeV. The results showed that the silicon content in the sputum of patients suffering from silicosis is, on the average, four times that of the samples used for reference. (auth) (UK)

40786 CHROMATOGRAPHIC SEPARATION OF ^{242}Cm AND ^{241}Am AND THE SPECTROSCOPIC DETERMINATION OF THEIR α ACTIVITY. Auer-Welsbach, Helga; Bildstein, H.; Muellner, P. (Institut fuer Chemie, Vienna). Monatsh. Chem., 98: 61-7(1967). (In German).

The separation of ^{242}Cm from ^{241}Am on the ion-exchange resin Dowex 50 W × 8 with α-hydroxyisobutyrate solutions is described. The elution positions were marked by the use of Sm and Pm as indicators; the elution order is Sm–Cm–Pm–Am. Elution curves are given for 0.25M $(NH_4)_xH_{1-x}$ hydroxyisobutyrate, where x = 0.60 for Sm, 0.65 for Cm, Pm, and Am, and 0.70 for tail fractions containing Nd. Drop and molecular plating samples were prepared for measuring α activities with semiconductor detectors. About 2×10^{-6} g ^{241}Am yielded 4×10^{-9} g ^{242}Cm on activation for 400 hr; the latter corresponded to 99.5% of the total observed activity. Representative spectra of drop and plating probes for a fraction are illustrated. (BBB)

40787 DETERMINATION OF THORIUM MICROIMPURITIES IN ZINC BY CONCENTRATION COPRECIPITATION. Shanya, M. V.; Chuiko, V. T.; Vasilenko, V. D. (Dnepropetrovsk State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Khim. Khim. Tekhnol., 10: 747-9(1967). (In Russian).

A method was developed for determining up to 10^{-6}% thorium impurities by coprecipitation of thorium from a zinc salt solution by means of fractionation with partial precipitation of zinc dioxide. (R.V.J.)

40788 DETERMINATION OF ^{14}C IN URANIUM CARBIDE. Lee, H. M. (London Univ.); Barrett, L. R. Int. J. Appl. Radiat. Isotop., 18: 661-3(Sept. 1967).

The method described involves oxidation of the carbide and absorption of the $^{14}CO_2$ formed in a modified Schöniger flask combustion apparatus. This apparatus is illustrated. Oxidation and trapping of the gas occurred simultaneously in the apparatus. Hyamine solution was used as the absorption medium and as a base for scintillation counting. Carbon-14 recovery was 86%. The method offers speed, simplicity, and accuracy. (UK)

40789 DISTRIBUTION OF RARE EARTHS AMONG COMPONENT MINERALS OF BRUDERHEIM CHONDRITE. Honda, Masatake; Shima, Masako (Tokyo Univ.). Earth Planet. Sci. Lett., 2: 344-8(July 1967).

The distribution of rare earth elements was studied among component minerals in an ordinary chondrite, Bruderheim. For this purpose a wet, fractional-phase, separation method was applied to a powdered sample of Bruderheim. Eleven members of this group of elements in the fractionated samples were determined by mass spectrometry and by neutron activation, without individual chemical separation. Most of the elements were found to be concentrated in the phosphate fraction, which was isolated mainly in EDTA solution. On the other hand, practically all of Eu and an important part of Yb were found in the HCl-insoluble silicate fraction. This result may indicate a lower oxidation level of the system in which the minerals were found. (auth)

40790 NEUTRON ACTIVATION OF TRACES IN ELECTROLYTIC ZINC SULPHATE SOLUTIONS. PART I. SIMULTANEOUS DETERMINATION OF MERCURY, URANIUM, AND YTTERBIUM. Dams, R.; Hoste, J. (Ghent Univ.). Anal. Chim. Acta, 39: 423-32(Dec. 1967).

A neutron activation determination of traces of mercury, uranium, and ytterbium in electrolytic zinc sulfate solutions was devised. The isotope ^{197}Hg was measured by means of its 68- and 77-keV photopeaks. Uranium was determined by measurement of the 106-keV photopeak of the ^{239}Np daughter activity. The 50- and 53-keV x rays of ytterbium isotopes ^{169}Yb and ^{175}Yb were counted using a 1-mm thick NaI(Tl) water crystal. The chemical separation was performed on anion exchange resin. The matrix activities were eliminated in 1.85 N hydrofluoric acid while the neptunium and ytterbium activities were desorbed with 5 N hydrochloric acid. Mercury was eluted from the column with 0.5 M thiourea–0.005 N hydrochloric acid and precipitated as sulfide. (auth)

40791 MEASUREMENT OF SMALL AEROSOL CONCENTRATIONS OF LONG-LIVED ALPHA SOURCES. Starcuk, Zenon (Vyzkumny Ustav Makromolekularni Chemie, Brno); Vydra, Miloslav. Jad. Energ., 13: 332-5(Sept. 1967). (In Czech).

A compensation or coincidence method was developed for measuring natural aerosols. The basic parameters were found for optimum compensation in the state of equilibrium, deflection due to the inequilibrate state, influence of statistical fluctuation of nuclear decay, and influence of incidental coincidences. The time delay between the warning signal of the presence of artificial radioactive aerosol and the moment of its appearance was estimated. (tr-auth)

40792 IDENTIFICATION OF RADIONUCLIDES BY MEANS OF PUNCHED CARDS. Vodrazkova, Milena; Kokta, Ladislav (Inst. for Research of Production and Application of Radioisotopes, Prague). Jad. Energ., 13: 300-1(Aug. 1967). (In Czech).

Brief data are given on the use of punched cards for fast information on standard energy spectra of α, β, and γ radiation and half-lives of radioisotopes. (tr-auth)

40793 ELECTROANALYTICAL METHODS IN NUCLEAR ENERGY. Alonso-Lopez, J.; Almagro Huertas, V. (Junta de Energia Nuclear, Madrid). Energ. Nucl. (Madrid), 11: 133-44 (Mar.-Apr. 1967). (In Spanish).

A bibliographic study was made of the electroanalytical methods with emphasis on the sensitivity and precision of the principal methods. Applications of electroanalytical methods to the determination and analysis of U, to the determination of the actinide elements, and to the determination and analysis of other elements used in nuclear energy are tabulated. (J.S.R.)

40794 NEUTRON ACTIVATION ANALYSIS OF Co, Zn, Cr, Sc, AND Ni TRACES IN ALFIANELLO AND ALBARETO METEORITES. Breccia, Alberto; Dellonte, Sergio; Nucifora, Giuseppina (Univ., Bologna. CNR, Bologna). Ric. Sci., 37: 319-22 (Apr. 1967). (In Italian).

Data on the neutron activation analysis of Co, Zn, Cr, Sc, and Ni traces in Alfianello and Albareto meteorites are presented. The separation of the radionuclides was carried out by ion exchange chromatography. The Albareto samples contained a greater amount of Zn and a smaller amount of Sc than the Alfianello samples. The different contents of these elements suggest that they are related to two different kinds of meteorites. (auth)

40795 FLUORESCENT X-RAY ANALYSIS OF HIGH-PURITY DYSPROSIUM OXIDE. Nakajima, Tokunosuke; Kawaguchi, Hiroshi; Ouchi, Yoshihiko (Japan Atomic Energy Research Inst., Tokyo). Bunseki Kagaku, 16: 832-4(Aug. 1967). (In Japanese).

Minor amounts (0.02 to 0.6%) of rare earth elements (Y, Er, Ho, Gd, Eu, and Sm) in dysprosium oxide of high purity were determined by fluorescent x-ray procedure. Samples and standards were prepared by briquetting the oxide powder. Probable errors at a concentration of 0.05% level estimated by a statistical method were 4% (for Y) to 17% (for Sm) for each element. Detection limits of rare earth oxides in dysprosium oxide ranged from 0.005% (for Y) to 0.02% (for Sm). (auth)

40796 COLLECTION OF ^{51}Cr IN SEAWATER. Iwashima, Kiyoshi; Momma, Toshiko (Inst. of Public Health, Tokyo). Bunseki Kagaku, 16: 831-2(Aug. 1967). (In Japanese).

Chromium-51 discharged into the sea and present mainly in the valence state of VI, was reduced to Cr(III) by iron(II) and collected by the ferric hydroxide coprecipitation method. The carrier of chromium (0.09 mg) was added to 50 ml of sea-water containing tracer ^{51}Cr and the pH of the mixture was brought to 1.8 by the addition of hydrochloric acid. A solution of iron(II) sulfate (0.6 mg Fe) was added to reduced Cr(VI) and the pH adjusted to 8 to precipitate hydroxides with sodium hydroxide after the addition of 2.25 mg of iron(III) as a collector. ^{51}Cr was collected rapidly and quantitatively as the hydroxide. The procedure also proved to be satisfactory in a larger scale operation (80-fold). Several other radioisotopes such as ^{54}Mn, ^{59}Fe, ^{60}Co, and ^{65}Zn were also coprecipitated quantitatively. It was found to be advantageous in the separation of chromium from the hydroxides precipitates that the reducing agent and the collecting agent be the same material, iron. (auth)

40797 X-RAY-FLUORESCENCE SPECTROMETRIC DETERMINATION OF RARE EARTH ELEMENTS BY SOLUTION METHOD. Asada, Eiichi; Matsuda, Shoji (Government Chemical Industrial Research Inst., Tokyo). Bunseki Kagaku, 16: 790-4(Aug. 1967). (In Japanese).

The addition method which is applicable to concentrated solutions, was applied to the determination of rare earth elements. The measurements were done separately on two classified groups, i.e., cerium-group elements and yttrium-group elements. Analytical lines were selected, K lines for the former and L lines for the latter, taking into consideration their mode of overlapping. Respective lines are tabulated. Studies were made on the treatment of higher background values for K series and also on the correction for some overlappings of L series spectra. The analysis of synthetic samples by this method gave values with less than 5% of relative errors in the presence of diverse elements. (auth)

40798 SOME SPECTS OF THE DETERMINATION OF FLUORINE NEUTRON ACTIVATION AT 14 MeV IN POLLUTED PLANTS. Debiard, Raymond; Fourcy, Andre; Garrec, Jean-Pierre (CEN, Grenoble, France). Compt. Rend., Ser. D, 264: 2668-71(June 5, 1967). (In French).

Determination of fluorine on leaves of apples and grapes sampled in polluted zones was reported. Neutron activation is compared with a chemical method. (tr-auth)

40799 TRACE ELEMENTS AND NEUTRON ACTIVATION ANALYSIS IN BIOLOGY AND MEDICINE. Karlicek, V.; Kott, J. (Clinic of Internal Diseases, Pizen, Czech.). Cas. Lek. Cesk., 106: 166-7(Feb. 10, 1967). (In Czech).

The biological effects of trace elements are discussed, the technique of neutron activation analysis is described, and its basic applications are evaluated. The use of activation analysis in cases where the material is available in very small amounts is described. (CFSTI)

40800 APPLICATION OF INELASTIC PROTON SCATTERING TO THE RAPID DETERMINATION OF SILICON IN STEELS. Pierce, T. B.; Peck, P. F.; Cuff, D. R. A. (Atomic Energy Research Establishment, Harwell, Eng.). Anal. Chim. Acta, 39: 433-6(Dec. 1967).

A rapid, nondestructive method for determining silicon in steels was developed based on the measurement of the 1.77-MeV γ-line emitted by the proton inelastic scattering reaction $^{28}Si(p,p')^{28}Si$. For some of the determinations the 0.84-MeV γ-line from the reaction $^{56}Fe(p,p')^{56}Fe$ was used as internal standard. (auth)

40801 DETERMINATION OF PHOSPHORUS IN ROCKS AND MINERALS BY ACTIVATION ANALYSIS. Henderson, P. (Oxford Univ.). Anal. Chim. Acta, 39: 512-15(Dec. 1967).

An initial zirconium phosphate precipitation was carried out prior to irradiation with thermal neutrons. Despite interfering reactions, results proved the method to be accurate with a relative standard deviation of about 2%. The method is not rapid; about 5 days are needed for the analysis of 12 samples with 3 standards, including preparation, counting, and yield determination. (J.G.B.)

40802 SURVEY OF CHROMATOGRAPHIC PAPERS FOR INTERFERING NUCLIDES IN ACTIVATION ANALYSIS. Smathers, James B.; Duffey, Dick; Lakshmanan, Sitarama (Walter Reed Army Inst. of Research, Washington, D. C. Univ. of Maryland, College Park, Md.). Anal. Chim. Acta, 39: 529-32 (Dec. 1967).

Twenty-three types of chromatographic papers were surveyed for the nuclides with high activation cross sections which on irradiation might contribute to the background activity of the paper. Each of the papers was studied to determine the following: the inherent nuclide content of the paper as purchased from the manufacturer; the effects of an 0.8N nitric acid wash on removal of inherent nuclides from the paper; and the use of a cadmium shield to suppress thermal neutron activation of the acid-washed papers and the resulting effect on the paper background. The effects of washing the paper in an organic solvent as well as complications offered by dust in the laboratory air were evaluated. Results of the activation analysis of the papers agreed with the limited data available in the literature. Acid-washing of the papers caused fraying and wrinkling damage, although it reduced considerably high contamination. (J.G.B.)

40803 SEPARATION AND DETERMINATION OF FLUORIDE IONS WITH THE HELP OF ORGANOSILICON COMPOUNDS. Bock, Rudolf; Semmler, Hans-Joachim (Johannes Gutenberg-Univ., Mainz). Z. Anal. Chem., 230: 161-84(1967). (In German).

The reaction products of fluoride with organic silicon compounds can be extracted from acid aqueous solutions by many different organic solvents. The velocity of this reaction is rather slow, but increases in solutions of high acidity. Fluoride can be back-extracted from organic fluorosilane solutions by half-saturated sodium hydrogencarbonate. Yet this process is slow, too. Preferably, fluoride can be determined as triethylfluorosilane directly in the organic phase by gas chromatography or mass spectrometry. The extraction of fluoride by means of these organosilicon compounds is specific; it is interfered with partly by zirconium and by high concentrations of silica, thorium, and vanadium. (auth)

40804 DENSITY DETERMINATION OF REFRACTORIES BY MEASUREMENT OF GAMMA-RADIATION ABSORPTION. Borbas, J. J.; Padfield, R. C.; Moscker, E. (Bethlehem Steel Corp., Pa.). J. Amer. Ceram. Soc., 50: 421-4(Aug. 21, 1967).

The radiation transmittance of specimens of nine types of brick having a wide range of densities was measured with a nuclear-density gage. A plot of radiation transmittance versus bulk density yielded the exponential curve typical for the fundamental radiation law, showing that the method is sensitive to wide density variations between bricks of different types. Further tests on larger groups of specific types showed that the method is less sensitive to smaller differences but is useful for determining variations in density within and between refractories of various compositions and thicknesses. (auth)

40805 IMPROVEMENTS IN THE ELECTROPHORETIC ANALYSIS OF RADIOACTIVE SUBSTANCES. Sachs, Charles (to Commissariat a l'Energie Atomique). British Patent 1,081,072. Aug. 31, 1967. Priority date Sept. 17, 1963, France.

The apparatus for electrophoretic analysis of mixtures containing radioactive constituents comprises a container for holding an elongated electrophoresis medium, an anode and a cathode for applying a potential between the opposite ends of the medium, and a cover parallel to the surface of the medium. The cover is opaque to radioactivity from the medium but includes a number of apertures spaced along the medium for receiving radioactivity counters for measuring the radiation passing through the apertures. (B.L.M.)

40806 AN ARRANGEMENT FOR THE QUANTITATIVE AND QUALITATIVE ANALYSIS OF MATERIAL MIXTURES OR CHEMICAL COMPOUNDS. Schwaar, Lothar (to Veb Vakutronik). British Patent 1,080,346. Aug. 23, 1967. Filed Oct. 29, 1964.

An arrangement for the qualitative and quantitative analysis of mixtures of materials or chemical compounds with the aid of fluorescent roentgen radiation comprises one or more semiconductor radiation detectors spaced from means for carrying the sample for analysis. The detector or detectors are connected to single-channel analyzer and a recording or indicating device. The detectors are preferably Li-drifted Ge or Si detectors. Means are provided for displacing the channel setting of the channel analyzer in a step-wise manner with the setting at each step corresponding to the K radiation of a particular element. The channel width at a particular channel setting is so dimensioned that an optimum sensitivity for each individual element may be achieved. (B.L.M.)

40807 SEPARATION AND SPECTROGRAPHIC DETERMINATION OF SAMARIUM, GADOLINIUM, THORIUM, AND URANIUM IN ZIRCONIUM METAL AND ALLOYS. Baksay, Ivan (Carborundum Metals Climax, Inc., Akron, N. Y.). 22p. (CONF-670308-2). DTIE.

From 18th Conference on Analytical Chemistry and Spectroscopy, Pittsburgh.

In the preparation of samples for spectrographic determination of concentrations of Sm, Gd, Th, and U of <10 ppM in Zr metal and alloy samples, separation of the four elements is accomplished by the following procedure: a La carrier is added to the sample, the sample is dissolved in H_2SO_4–HF, buffered with NH_4F, the fluoride precipitate filtered and washed, the precipitate ignited at 900°C, and a weighed aliquot of the sample and a weighed aliquot of graphite powder mixed and transferred to a cup electrode. The elements are then determined in the usual spectrographic manner. The results and precision of the analyses are discussed in detail. (B.L.M.)

40808 COMPILATION OF MASS SPECTRAL DATA. Cornu, A.; Massot, R. London, Heyden and Son Ltd., 1966. 630p.

Several classifications of the principal parameters of about 5000 mass spectra are presented. Identification and analysis of organic compounds by mass spectrometry are facilitated. (auth)

40809 DIGITAL COMPUTER TECHNIQUE FOR QUALITATIVE ANALYSIS OF COMPLEX SAMPLES FROM THEIR NEUTRON-INDUCED GAMMA-RAY ACTIVITIES. Robins, Clinton Howard Jr. Blacksburg, Va., Virginia Polytechnic Inst., 1967. 142p.

Thesis.

A digital computer technique was developed for determination of the elemental constituents of an unknown specimen from a set of time-dependent gamma spectra measured subsequent to neutron activation of the specimen The technique is based on a new approach to spectrum stripping, which permits the analysis of samples of much greater complexity than is possible with existing computer procedures. In addition, the method is readily adaptable for use in automated activation analysis systems and is potentially capable of being modified for use with a quantitative analysis program. The requirements for application of the technique are essentially the same as those for any other method of neutron activation analysis. The primary disadvantage of the technique as compared with a previously developed spectrum stripping computer method is that the stripping operation must be performed a greater number of times. Identification of the isotopes in a complex sample is made on the basis of a determination of their gamma energies and half-lives. This procedure is repeated for each spectrum starting with the last in the time-dependent set and terminating with the third. Once the gamma energies and half-lives are determined, the actual determination of the isotopic composition of the sample can be performed either by hand or with the aid of the computer. The ability of the present technique to analyze more complex spectra than a previously developed method is made possible in several ways. The most important of these is the performance of the majority of the stripping with "dummy" gamma spectra representing the response of the detector system to monoenergetic gamma rays of the same energies as the various peaks in the unknown sample spectra. Use of these dummy gamma spectra greatly reduces the number of library spectra required, and aids in preventing the use of the wrong library spectrum in the stripping process. Other features that contribute to the capability of the present method to analyze more complex spectra include the addition of a spectra data smoothing technique to prevent identification of nonexisting peaks and improve the accuracy of the stripping procedure; initiation of the analysis with the last spectrum in the time-dependent set instead of the first to reduce the peak overlap problem; and the use of more sophisticated tests in the determination of peaks. A FORTRAN IV program of the technique was written. The program requires as input a set of

not less than three and not more than ten gamma spectra of the neutron activated unknown sample, the temporal parameters associated with the accumulation of these spectra, a parameter used in the smoothing of these spectra, and a number of peak determination test parameters whose values are determined by the multichannel analyzer used to accumulate the spectra. In addition, a set of "dummy" gamma library spectra spanning the energy range of the analyzer together with a limited number of "real" library spectra must also be supplied. (Disser. Abstr.)

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Refer also to abstracts 40772, 40921, 40957, 40959, 40972, 41575, 41606, 42516, and 42517.

40810 (AD-647366) ISOTOPE EFFECTS IN THE DIFFUSION AND SOLUBILITY OF HYDROGEN IN NICKEL AND QUANTUM MASS EFFECTS IN DIFFUSION. Ebisuzaki, Y.; Kass, W. J.; O'Keeffe, M. (Arizona State Univ., Tempe. Dept. of Chemistry). Jan. 1, 1967. Contract Nonr-2794(04). 31p. (TR-5). CFSTI.

The solubility and diffusivity of hydrogen and deuterium in a single crystal of nickel were measured in the range 490 to 690°K. The theory of isotope effects was developed in the harmonic approximation. It is shown that the experimental results can be quantitatively accounted for in terms of the derived expressions. The theory was tested by calculation of the pre-exponential factor for diffusion (Do) using only the data for the relative diffusivities of hydrogen and deuterium. The calculated value is in excellent agreement with experiment if it is assumed that direct jumps of hydrogen from one octahedral site to another are involved. A supplementary note discusses the temperature dependence of the ratio of isotope diffusion coefficients with particular reference to hydrogen in metals. (TAB)

40811 (AD-649325) OPTICAL ABSORPTION SPECTRUM AND OPTICAL ZEEMAN EFFECT IN TRIPLY IONIZED YTTERBIUM-DOPED CALCIUM TUNGSTATE. Jones, George (Harry Diamond Labs., Washington, D. C.). Dec. 1966. 25p. (HDL-TR-1336). CFSTI.

The absorption spectrum of 0.01- to 0.05% ytterbium-doped calcium tungstate at liquid helium temperature was measured. Some of the samples contained Na for charge compensation. The effect of Na charge compensation for Yb was similar to that for Na-compensated Ce in the same host. The spectrum contains an extensive complex structure that is not explained by present theory. Two vibronic lines associated with the lattice modes previously reported are identified. The crystal field parameters were calculated to fit the main lines of the spectrum. These were calculated with and without mixture of states of unequal J. Measurements of the Zeeman effect allow the unambiguous identification of the lowest 2F5/2 symmetry. In terms of the free-ion J M states, this level consists of a combination of M = plus or minus 5/2 and plus or minus 3/2 function. The g values observed at 31 koe for this state are g (parallel) = 1.2 plus or minus 0.1 and g (perpendicular) = 1.5 plus or minus 0.1. (auth) (TAB)

40812 (AGN-8235) ALKALI METALS EVALUATION PROGRAM. Quarterly Progress Report, April 1-June 30, 1967. Achener, P. Y. (Aerojet-General Corp., San Ramon, Calif. Nuclear Products and Services Group). Aug. 1967. Contract AT(04-3)-368. 16p. Dep. CFSTI.

Developments are reported for studies on: determination of thermodynamic and transport properties for Rb, Cs, and K; and thermodynamic and transport properties of alkali metals for heat pipe applications. (P.C.H.)

40813 (CALT-532-15) STUDIES IN CHEMICAL DYNAMICS AND RADIATION CHEMISTRY. Technical Progress Report, July 1, 1966-June 30, 1967. Kuppermann, Aron (California Inst. of Tech., Pasadena). Aug. 31, 1967. Contract AT(04-3)-532. 50p. Dep. CFSTI.

Research progress is reported on diffusion kinetics, low-energy electron scattering, elementary reactions by photolysis at variable wavelength, reaction in crossed molecular beams, and theory of chemical reactions. (M.C.G.)

40814 (COO-504-11) THERMODYNAMIC PROPERTIES OF SOLUTIONS. Final Report. Gucker, Frank T. (Indiana Univ., Bloomington. Dept. of Chemistry). July 7, 1967. Contract AT-(11-1)-504. 17p. (CONF-670913-4). Dep. CFSTI.

From Symposium on New Investigations in Thermodynamics, Thermochemistry, and Transport Properties, Heidelberg, Germany.

Measurements were made on the adiabatic compressibilities and sound velocities of aqueous solutions of some alkali halides at 25°C. Values for the sound velocities in dilute solution increased with concentration for some salts and decreased for others. The limiting slope was positive for alkali halides of low molecular weight and, with the exception of LiCl, decreased as the weight of either anion or cation increased. The adiabatic compressibility, β_S, of each solution was obtained from its density, d, and sound velocity by the equation $\beta_S = (\partial \ln V/\partial P)_S = 1/u^2 d$, where V, P, and S are volume, pressure, and entropy, respectively. Data are given in graphic form. The development of an ultrasonic interferometer for studies on dilute solutions is described. Measurements were made on the specific heats of aqueous solutions of KCl, NaCl, and NaBr from about 0.1 M to near saturation, at 5, 25, 45, 65, and 85°C. Plots of the apparent molar heat capacities against $\underline{M}^{\frac{1}{2}}$ increased rapidly at low temperatures, where the curves were definitely sigmoid, with maximum slope near the middle; and all became flatter at higher temperatures. The apparent molar heat capacities at infinite dilution increased rapidly at lower temperature, then went through a maximum at 60°C instead of increasing. (P.C.H.)

40815 (UCRL-17628) HIGH TEMPERATURE VAPORIZATION MECHANISMS. Somorjai, Gabor A. (California Univ., Berkeley. Lawrence Radiation Lab.). June 1967. Contract W-7405-eng-48. 42p. (CONF-670935-1). Dep. CFSTI.

From 3rd International Symposium High Temperature Technology, Pacific Grove, Calif.

Experimental information about the vaporization mechanism of solids is obtained from evaporation rate measurements which are carried out far from equilibrium. In such studies one stable face of a single crystal should be used. Vacuum evaporation rates of solids which undergo structural rearrangement, dissociation, or association upon vaporization are, in general, markedly lower ($\alpha \ll 1$) than the maximum evaporation rate ($\alpha = 1$) predicted by the Hertz-Knudsen-Langmuir equation. The rate controlling step in the vaporization process, in most cases, is a surface reaction followed by the rapid desorption of the vaporizing species. It is expected that most refractory compounds (carbides, oxides, borides, and nitrides) can have vacuum evaporation rates which are several orders of magnitude lower than the maximum rate derived from equilibrium studies. Several mechanisms leading to congruent and non-congruent vaporization are discussed. The vaporization characteristics of the different groups of refractory solids are summarized. Experiments are suggested to elucidate the mechanism of vaporization of refractory materials. (58 references). (auth)

40816 ON THE LIMITATION OF THE WORKING TEMPERATURE OF GALVANIC OXYGEN MEASURING CELLS WITH THORIUM OXIDE AND ZIRCONIUM OXIDE SOLID ELECTROLYTES. Ullmann, H. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Z. Chem., 7: 65-7 (Feb. 1967). (In German).

The ionic conductivity was measured with the cell $Pt,O_2(p')/$ solid electrolyte$/O_2\,p'')$,Pt, by obtaining E/E_0, E_0 being the thermodynamically, calculated EMF and E the observed. The electrolytes used were ThO_2 + 20 mole % $YO_{1.5}$, ThO_2 + 6.2 mole % CaO + 1.2 w % Al_2O_3 + 1.4% SiO_2, ZrO_2 + 11 mole % MgO, and ZrO_2 + 5 w % CaO + MgO. For these electrolytes, E/E_0 is a linear function of temperature below 410, 730, 450, and 520°C, respectively; above these temperatures it is essentially independent of temperature. The temperature dependence of the specific conductivity was also shown to agree closely with a change in behavior at these temperatures. A change in the conduction mechanism for the four cells was found at 380, 740, 420, and 550°C, respectively. (BBB)

40817 PROCEDURE FOR STUDYING THE OXIDATION OF A PULVERULENT METAL AT MODERATE TEMPERATURES AND LOW OXYGEN PRESSURES: EXAMPLE OF TUNGSTEN. Dufour, Louis-Claude (CNRS, Dijon, France). Bull. Soc. Chim. France, No. 7, 2333-46 (July 1967). (In French).

The same fundamental kinetic data were found in the oxidation of tungsten under a low oxygen pressure (0.1 torr to 200 torr) for the metal in the form of a smooth plate or as a powder of micron size. In the range of temperatures studied (400 to 600°C), oxidation followed the common parabolic law transformed by introducing the variation of the reacting interface during the reaction; the same values were obtained for the diffusion constants and the activation energy (38 kcal $mole^{-1}$) as in the case of the compact metal. The low effect of the oxygen pressure led to a consideration of the predominant diffusion of metallic ions as the regulating process. Nevertheless, at lower pressures, an increasing effect of pressure due to the decrease of the nucleation rate was found. Taking into account the distribution of the particle diameters, porosity of the oxide has only a small effect on its protective properties. (auth)

40818 THE HEAT OF SOLUTION OF CURIUM METAL AND THE HEATS OF FORMATION OF $Cm^{+3}_{(aq)}$ AND $CmCl_{3(c)}$. Wallmann, J. C.; Fuger, J.; Haug, H.; Marei, S. A.; Bansal, B. M. (Univ. of California, Berkeley). J. Inorg. Nucl. Chem., 29: 2097–9(Aug. 1967).

The heat of solution of curium metal in 1M HCl at 298.4 ± 0.2°K was measured and found to be −140.2 ± 1 kcal/mole. Calculated values for the heats of formation of $CmCl_{3(c)}$ and $Cm^{+3}_{(aq)}$ are −226.4 ± 1.2 and −140.9 ± 1.3 kcal/mole, respectively. (auth) (UK)

40819 KINETIC SOLVENT ISOTOPE EFFECT IN THE HYDROLYSIS OF SULPHONIC ANHYDRIDES. Christensen, N. Hesselbjerg (Danish Atomic Energy Commission, Risoe). Acta Chem. Scand., 21: 899-904(1967).

The hydrolysis of m-nitro-, p-bromo- and p-methylbenzenesulphonic anhydride was studied kinetically in aqueous dioxane and aqueous acetone at room temperature. Rate constants in mixtures containing light water or heavy water were determined in the solvent composition range from 6 to 76 vol % water. The variation of hydrolysis rate with solvent composition suggests that the hydrolysis follows an S_N2 mechanism, except for toluene sulphonic anhydride at higher water contents, where the hydrolysis appears to follow an S_N1-like mechanism. There was no significant change in the kinetic solvent isotope effect with substrate, solvent, and solvent composition. These findings are compared with data from the literature. (auth) (DENMARK)

40820 DISSOCIATION PRESSURES AND PARTIAL THERMODYNAMIC QUANTITIES FOR AMERICIUM OXIDES. Chikalla, T. D. (Battelle Memorial Inst., Richland, Wash.); Eyring, L. Contract AT(45-1)-1830. J. Inorg. Nucl. Chem., 29: 2281-93 (Sept. 1967).

A thermogravimetric isopiestic technique was used to measure the oxygen dissociation pressures over substoichiometric americium dioxides. The temperature and pressure range investigated was 866 to 1172°C and from one to below 10^{-6} atm O_2, respectively. The nonstoichiometric compositions encountered under these conditions covered the interval $1.80 < O/Am < 2.00$. The relative partial molar enthalpy and entropy of solution of oxygen in AmO_{2-x}, calculated from the experimental dissociation pressures, were found to be a function of composition, but independent of temperature in the region studied. A sharp change in slope on both the $\Delta\bar{H}(O_2)$ and $\Delta\bar{S}(O_2)$ vs. composition plots occurred at about $AmO_{1.98}$. (auth) (UK)

40821 SYNTHESIS OF URANIUM MONOARSENIDE (UAs). Baskin, Y. (Argonne National Lab., Ill.). J. Inorg. Nucl. Chem. 29: 2480-2(Sept. 1967).

The method employed for the preparation consisted of reacting finely divided uranium with arsine gas at 300°C. Experimental details are given. A mixture of UAs_2 and UH_3 was obtained, presumably according to $1.0\ U + 1.2\ AsH_3 \rightarrow 0.6\ UAs_2 + 0.4\ UH_3 + 1.2\ H_2$. This mixture was heated in vacuum up to 1400°C to homogenize the material and drive off the hydrogen and excess arsenic, and the homogenized material passed through a 325 mesh screen to remove particles of uranium. Debye–Scherrer powder patterns were employed to identify phases and to obtain lattice parameters. Strong and very sharp UAs patterns were obtained, with lattice constant 5.779 ± 0.001 Å. Results of chemical analysis are tabulated, and within the limits of analytical error the compound was found to be stoichiometric. The compound gradually oxidises in air at room temperature, and ignites at about 290°C, showing a sharp exothermic peak on the thermogram. (UK)

40822 TRIPHENYLPHOSPHONIUM AND TRIPHENYLPHOSPHINE OXIDE COMPLEXES OF SOME HIGHER VALENT METALS. Majumdar A. K.; Bhattacharyya, R. G. (Jadavpur Univ., Calcutta). J. Inorg. Nucl. Chem. 29: 2359-64(Sept. 1967).

Methods of preparation and properties of the triphenylphosphonium hydroxochlorocomplexes of the metals zirconium, thorium, uranium, and tungsten and those of triphenylphosphine oxide complexes of zirconium, thorium, and vanadium are described. These complexes were characterized by ir spectra. (auth) (UK)

40823 PHOTOCHEMICAL OXIDATION OF NEPTUNIUM(V) BY XENON TRIOXIDE. Cleveland, J. M.; Werkema, G. J. (Dow Chemical Co., Rocky Flats, Colo.). Nature (London), 215: 732-3 (Aug. 12, 1967).

XeO_3 is a strong oxidising agent, with a potential of −1.8v. Evidence was obtained for a photochemical reaction $6\ Np(V) + Xe(VI) \rightarrow 6\ Np(VI) + Xe$. The experimental technique adopted is described, and all runs were conducted at 60°C to give a conveniently measurable rate. The concentration of Np(V) was followed at 980 mμ, and the several steps of data reduction were evaluated by computer program. Rate constants are tabulated. It was concluded that the reaction is first order in XeO_3 and zero order in Np(V). The rate appeared independent of acidity in the 0.5 to 2 M range. The reaction appears to be photochemical, involving the excited species XeO_3^*, and formation of this species appears to be the rate controlling step. The excited species reacts rapidly with the Np(V). Runs conducted outside the spectrophotometer light path did not obey the same rate law; reaction was much slower, and was non-integral dependent on Np(V), XeO_3, and possibly Np(VI) concentrations. It appears that XeO_3 oxidises by a two-electron change mechanism, and that the oxidation is hindered in cases where only a one-electron change is permissible. (UK)

40824 ON THE PREPARATION OF ELECTRON-RICH COMPOUNDS OF THE LANTHANIDE ELEMENTS CERIUM, NEODYMIUM, AND YTTERBIUM WITH 2,2'-DIPYRIDYL. Herzog, S.; Schuster, R. (Ernst-Moritz-Arndt-Univ., Griefswald, Ger.). Z. Chem., 7: 26-7(Jan. 1967). (In German).

The tetrahydrofuran adducts of the bromides of Ce, Nd, and Yb were reacted with 2,2'-dipyridyl in tetrahydrofuran to yield $CeBr_3 \cdot 2\frac{1}{2}Dipy$, $NdBr_3 \cdot 2Dipy$, and $YbBr_3 \cdot 2Dipy$. These or the tetrahydrofuran adducts reacted with dilithium dipyridyl and excess dipyridyl in tetrahydrofuran to yield $CeDipy_4$, $NdDipy_4$, and $LiYbDipy_4 \cdot 3THF$. The first two of these are quite unstable in the presence of air, insoluble in most organic and decomposed by most polar solvents; anaerobic iodination consumes 3 gram atoms of I. $CeDipy_4$ gives a value of 2.85 Bohr magnetons; $NdDipy_4$, 3.62 Bohr magnetons. The Yb compound consumes 3.75 gram atoms I, and corresponds to 4.85 Bohr magnetons. Thus the Ce earths and Y earths may be distinguished by the products formed in the reaction. (BBB)

40825 ABSORPTION SPECTRA OF Bk^{3+} AND Bk^{4+} IN SOLUTION. Gutmacher, R. G.; Hulet, E. K.; Lougheed, R.; Conway, J. G.; Carnall, W. T.; Cohen, D.; Keenan, T. K.; Baybarz, R. D. (Univ. of California, Livermore). J. Inorg. Nucl. Chem., 29: 2341-5(Sept. 1967).

Sixteen absorption bands of Bk^{3+} in the region from 3200 to 15,000 Å are reported. The spectrum was studied in a variety of aqueous acid solutions, at Bk concentrations of 3.6×10^{-3} M or less. The weaker bands were enhanced by the use of time-averaging techniques, followed by computer processing of the data. Berkelium was oxidized to the quadrivalent state with sodium bismuthate and a partial observation of its absorption spectrum was made. The radiolytic reduction of Bk^{4+} proceeds at a linear rate. The quadrivalent state has a half-life of 2.8 hr in 5 M $HClO_4$ solution. (auth) (UK)

40826 INFRARED SPECTRA OF LITHIUM, SODIUM, AND POTASSIUM AMIDOALUMINATES. Brec, Raymond; Novak, Alexandre; Rouxel, Jean (Faculte des Sciences, Nantes, France, CNRS, Thiais, France). Bull. Soc. Chim. France, No. 7, 2432-5 (July 1967). (In French).

Infrared spectra of amidoaluminates, $MAl(NH_2)_4$, (with M = Li, Na, and K) and their deuterated derivates, were studied between 4,000 and 200 cm^{-1} at room temperature and at −180°C. The absence of hydrogen bonds in these compounds was noted. A study of NH_2 stretching bands showed nonequivalence of these groups for lithium and potassium, which suggests different crystal structures for the three compounds. (auth)

40827 ISOTOPIC EXCHANGE OF ^{18}O FROM CARBON DIOXIDE WITH OXYGEN IONS OF NICKEL OXIDE. Bailly, J.-Cl.; Teichner, S. J. (Univ., Lyon). Bull. Soc. Chim. France, No. 7, 2376-81(July 1967). (In French).

At room temperature, carbon dioxide containing ^{18}O exchanged with ^{16}O from the lattice of nickel oxide. The fraction of the surface of NiO which participates in this exchange (0.25) is slightly greater than the surface coverage of NiO by irreversibly adsorbed CO_2. An activation energy of 1 kcal/mole was found in the temperature range 23 to 50°C. The surface migration of adsorbed species probably represents the slowest step of the exchange process. (auth)

40828 THE OBSERVATION OF A VARIATION TO THE MATTHIESSEN LAW IN Zr. Renucci, Louis; Langeron, Jean-Paul (Centre d'Etudes de Chimie Metallurgique, Vitry-sur-Seine, France). Compt. Rend., Ser. C, 264: 2012-14(June 19, 1967). (In French).

The Matthiessen law was not followed in Zr at the temperature of liquid hydrogen. An expression of electric resistivity as a function of the temperature and purity was proposed with the form $\rho = f(m)H(T) + G(T)$. The difference observed between the coefficients of the oxygen effect, measured at 20.4°K and room temperature, is explained. (tr-auth)

40829 FAST DETERMINATION OF THE REDUCING ACTIVITY OF LITHIUM DEUTERIDE. Bengsch, E. (CNRS, Paris). Bull. Soc. Chim. France, No. 7, 2294-5(July 1967). (In French).

A fast method for determining the reducing activity of lithium deuteride by iodometry is described. A reaction was carried out in a moisture-free atmosphere between solid LiD and an excess of a 0.6 N solution of iodine in benzene containing 15% diethyl ether. Back titration was done with sodium thiosulfate. The precision is about 1%; it is close to this figure in the case of LiH. (auth)

40830 SOME REMARKS ON THE METHODICS OF APPLYING A RADIOACTIVE SOURCE FOR MEASURING THE INTERFACIAL POTENTIAL. Kamienski, B.; Kulawik, I.; Kulawik, J.; Mikulski, J.; Pawelek, J. (Inst. of Physical Chemistry, Polish Academy of Science, Krakow. Jagiellonian Univ., Krakow. Inst. of Nuclear Physics, Polish Academy of Sciences, Krakow). Bull. Acad. Pol. Sci., Ser. Sci. Chim., 15: 249-52(1967).

Studies were made on the use of ^{239}Pu electrode for measuring interfacial potentials. A preparation of plutonium oxide was embedded in a 15 mm layer of resin and its activity attained 1 μC. The air resistance between the radioactive source and the free surface of a solution was measured as the function of their mutual distance. The air resistance decreased sharply as the distance between the surface and the electrode was increased, passed through a minimum and then gradually rose. The minimum value occurred at a distance of 15 to 20 mm. In addition to its being indifferent to the vapors and gases present in the laboratory, the ^{239}Pu electrode did not require any special treatment after having been accidentally wetted with the investigated solution, and its potential remained constant. (P.C.H.)

40831 APPLICATION OF A ^{239}Pu ELECTRODE FOR THE DETERMINATION OF INTERFACIAL ELECTRIC POTENTIALS. Kamienski, B.; Kulawik, I.; Kulawik, J.; Mikulski, J.; Pawelek, J. (Inst. of Physical Chemistry, Polish Academy of Science, Krakow. Jagiellonian Univ., Krakow. Inst. of Nuclear Physics, Polish Academy of Sciences, Krakow). Bull. Acad. Pol. Sci., Ser. Sci. Chim., 15: 253-56(1967).

Distribution potentials at the water–organic interface were measured in the system: Hg/Hg_2Cl_2 1 N KCl aqueous solution of electrolyte M^+X^-/organic phase/air/Ag. A special vessel was constructed which allowed the surface of the organic liquid to be renewed and thus contaminations and accidental charges to be removed. A radioactive ^{239}Pu electrode was suspended about 15 mm above the fresh surface of the organic phase. The activity of the electrode was about 1 μC. Ionic distribution potentials $\Delta\Psi M/N$ across the water–nitrobenzene interface at 25°C were computed from the equation containing the measured EMF values: $\Delta\Psi M/N = E_{MX} - E_{NX}$, where E_{MX} denotes the EMF of the system containing the dissolved MX compound in both phases (aqueous and organic), and E_{NX} is the EMF of the system containing the NX compound dissolved in both phases. Data are tabulated. (P.C.H.)

40832 LOW-TEMPERATURE HEAT CAPACITY AND THERMODYNAMICAL FUNCTIONS OF ANTIFERROMAGNETIC URANIUM DIPHOSPHIDE UP_2. Stalinski, B.; Bieganski, Z.; Troc, R. (Inst. of Low-Temperature and Structural Research, Polish Academy of Sciences, Wroclaw). Bull. Acad. Pol. Sci., Ser. Sci. Chim., 15: 257-60(1967).

The heat capacity of UP_2 was measured within the temperature range 22.5 to 350°K and was found to be represented as the sum of three contributions: the lattice contribution, C_L; the electronic contribution, C_E; and the magnetic contribution, C_M ($C = C_L + C_E + C_M$). Subsequently, the entropy change, ΔS = 1.3 cal $mole^{-1}$ deg^{-1} and the energy change E_M = 204.5 cal $mole^{-1}$ for the magnetic transition were calculated by appropriate integrations of $(C_M/T)\,dT$ and $C_M\,dT$, respectively. (P.C.H.)

40833 SOME OBSERVATIONS ON THE CHEMISTRY OF URANIUM AND PLUTONIUM IN ANHYDROUS ACETIC ACID. Alei, M. Jr.; Johnson, Q. C.; Cowan, Helen D.; Lemons, J. F. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. J. Inorg. Nucl. Chem., 29: 2327-39(Sept. 1967). (LA-DC-8658).

In a survey of the chemistry of uranium and plutonium in anhydrous acetic acid it was found that the oxidation states U(III), U(IV), U(VI), Pu(III), Pu(IV), and Pu(VI) are reasonably stable in this medium. Visible spectra are presented and a number of reactions and equilibria involving these oxidation states in anhydrous acetic acid are reported. (auth) (UK)

40834 KINETICS OF THE REGULARITY OF THE REGULATION-INDUCED CHEMISORPTION OF O_2 ON THE SURFACE OF γ-Al_2O_3. Kolbanovskii, Yu. A.; Masterova, M. N. (Inst. of Petroleum Chemical Synthesis, Moscow). Kinet. Kataliz, 8: 309-15(Mar.–Apr. 1967). (In Russian).

A study was made of the kinetics of the chemisorption of O_2 on γ-Al_2O_3 in a radiation field in the temperature interval from 195 to 610°K. The presence of two temperature zones was found: the first zone (T < 425 K) is characterized by the absence of a temperature dependent of the initial chemisorption velocity, appearing in this zone are definite radiation, almost irreversible, processes having a zero order with respect to pressure, and the second zone (T > 425 K) is characterized by the negative temperature coefficients of the initial velocity and the dependence of the equilibrium pressure on the dose output. The value of the velocity and activation energy constants of some processes were determined. Possible mechanisms for the chemisorption for the I and II temperature zones were proposed. (tr-auth)

40835 CRYSTALLOGRAPHY OF URANYL DIETHYLDITHIOCARBAMATE. III. TRIGONAL $UO_2[S_2CN(C_2H_5)_2]_2$–$[H_2N(C_2H_5)_2]$. Cioni, Claudio; Franzini, Marco; Troysi, Mirella. Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur., 42: 69-75(Jan. 1967). (In Italian).

Results of the crystallographic study of the trigonal compound $UO_2[S_2CN\,C_2H_5|_2]_2$–$[H_2N(C_2H_5)_2]$ are reported. The relations between the lattice geometry of the trigonal compound, of its monoclinic polymorph, and of the rhombic pseudotetragonal compound $NaUO_2[S_2CN(C_2H_5)_2]_3 \cdot 3\,H_2O$ are discussed. (auth)

40836 METAL NITRATE–TRIBUTYL PHOSPHATE AND RELATED EXCHANGE STUDIES BY MEANS OF NUCLEAR MAGNETIC RESONANCE. Siddall, T. H.; Stewart, W. E. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Inorg. Nucl. Chem. Lett., 3: 279-84(Aug. 1967).

Simultaneous observation of separate proton magnetic resonance signals is reported for bound and free TBP molecules in solutions of metal nitrates containing excess TBP, and in particular TBP solutions of uranyl nitrate. The PMR spectrogram at −50°C of a $CDCl_3$ solution of $UO_2(NO_3)_2 \cdot 2TBP$ containing excess TBP is reproduced, showing two distinct sets of signals for the α-protons. It is believed that this spectrogram represents the first direct physical evidence that two molecules are coordinated to U in a solution containing excess TBP. At −20°C the separate sets of signals are extensively exchange broadened, and they coalesce into a single unresolved hump at −10°C, sharpening into a single set at higher temperatures. The exchange lifetime at −10°C was of the order of 10^{-3} sec., and the free energy of the exchange process was ~10k cal/mole. Results with uranyl nitrate adducts of tri-2-propyl phosphate and tris (4-methyl-3-pentyl) phosphate were similar except that exchange was much slower. The TBP results may be explained speculatively by assuming that the rate limiting process is $UO_2(NO_3)_2 \cdot 2TBP + TBP \rightleftharpoons UO_2(NO_3)_2 \cdot 3TBP$ (activated state). Exchange was more rapid in hexane than in $CDCl_3$, since hexane does not hydrogen bond to free TBP. Separate signal patterns and TBP exchange were also observed for free TBP and TBP bound to praseodymium nitrate or thorium nitrate in $CDCl_3$; also for the following binary mixtures of metal nitrates with no excess TBP: $-UO_2(NO_3)_2$–$Pr(NO_3)_3$, $Th(NO_3)_4$–$Pr(NO_3)_3$, and $La(NO_3)_3$–$Pr(NO_3)_3$. The observations suggest that slow exchange of anions might also occur at low temperatures, and some evidence for this is presented. The slow exchange at low temperature allowed measurement of the relative affinity of uranyl nitrate for two different extractants (TBP and tri-2-propyl phosphate). It is evident that a great variety of exchange reactions and rate studies are accessible by NMR experiments with these and similar systems. (UK)

40837 INVESTIGATION OF SYNTHESIS OF STRONTIUM ZIRCONATE AND HAFNATE. Bilik, V. Ya. Dopov. Akad. Nauk Ukr. RSR, Ser. B, No. 7, 618-20(July 1967). (In Ukrainian).

The kinetics of synthesis was studied in a solid phase of strontium zirconate and hafnate in relation to the annealing temperature and exposure time by the selective solution method. It is shown that ~99% of synthesis took place at 1750°C and an exposure time of 4 hours. The coefficients of the equation $K = A \cdot \exp(-E/RT)$ in the investigated reaction of $SrZrO_3$ and $SrHfO_3$ are A = 79.4 and 57.3 hr^{-1}, respectively; E is equal to 19.4 and 19.6 kcal per mole. (auth)

40838 INFRARED ABSORPTION SPECTRA OF CeO_2, Pr_6O_{11}, Nd_2O_3, AND Sm_2O_3. Petru, F.; Muck, A. (Chemisch-Technologische Hochschule, Prague). Z. Chem., 7: 27(Jan. 1967). (In German).

Infrared analysis of cerium earths was made; Pr_6O_{11} spectra were recorded in KBr, the others in Nujol between KBr plates. The spectra are illustrated, and the observed valence vibrations compared with the values for absorptions calculated from crystallographic Me–O distances, bond orders (CeO_2 = 2; Pr_6O_{11}, 1.83; Nd_2O_3 and Sm_2O_3, 1.5), and electronegativities (Ce, 1.2; Pr, 1.2; Nd, 1.3; Sm, 1.3). The values for ν_{calc} (cm^{-1}), ν_{obs} (cm^{-1}), and % error are as follows: CeO_2, 601, 570, 5.4; Pr_6O_{11}, 588, 595, −1.2;

Nd_2O_3, 523, 515, 1.6; and Sm_2O_3, 541, 545, –0.7. Thus values for this series of oxides may be predicted with sufficient accuracy to place the observed values in the proper sequence and to allow determination of the metal. The maximum is moderately strong and shifts to longer wavelength with increasing Me–O distance, or at the same distance with lowered force constant and bond order. (BBB)

40839 REDUCTION VOLTAGE AND THERMODYNAMICS OF THE FORMATION OF LIQUID CERIUM DI- AND TRICHLORIDES. Smirnov, M. V.; Lbov, V. S. Tr. Inst. Elektrokhim., Akad. Nauk SSSR, Ural. Filial, No. 8, 3-6(1966). (In Russian).

The electromotive force of the element $Ce_{(liq)}$ | fused $CeCl_3$–$CeCl_3$ || fused $CeCl_3$ | $Cl_{2(g)}$, C was measured in the temperature interval from 830 to 970°. From the experimental data the expressions for the temperature dependence of the reduction voltage of the liquid cerium tri- and dichlorides and the oxidation-reduction potentials of their mixtures were found. The thermodynamic magnitudes (Gibbs energy, enthalpy, and entropy) were calculated for the liquid cerium tri- and dichlorides. (tr-auth)

40840 ELECTRIC CONDUCTIVITY AND TRANSFERENCE NUMBER IN FUSED $CeCl_3$ AND $CeCl_3$–Ce. Smirnov, M. V.; Lbov, V. S. Tr. Inst. Elektrokhim., Akad. Nauk SSSR, Ural. Filial, No. 8, 7-12(1966). (In Russian).

The specific electric conductivity of the melts in the system $CeCl_3$–Ce was measured in the interval from pure $CeCl_3$ to $CeCl_{2.11}$ at temperatures from 480 to 980°C. It was established that the specific electric conductivity in the melts has a maximum near 3.4 ohm^{-1} cm^{-1} at the composition $CeCl_{2.5}$ (50 mol % $CeCl_3$ + 50 mole % $CeCl_2$). The hypothesis was expressed that in melts of the composition $CeCl_{2.65}$ up to $CeCl_{2.25}$ the electron conductivity is superposed on the ion conductivity, the electron fraction of which increases with approach of the mole ratio [Ce(III)] : [Ce(II)] to unity. The ion conductivity of the melt increases to the extent of the substitution in the melt of trivalent cerium by divalent cerium. The transfer numbers of cerium cations and chlorine anions in the melts $CeCl_3$ and 0.11 $CeCl_3$ + 0.89 $CeCl_2$ were measured at 900° in comparison with porous asbestos diaphragms. It was found that in $CeCl_3$ the current through the diaphragm is transmitted by chloride ions ($n_a \cong 0.8$) and in $CeCl_{2.11}$ the transfer of current with the cations increases up to $n_c \cong 0.45$ as a result of the reduction of trivalent cerium to divalent cerium. (tr-auth)

40841 EQUILIBRIUM POTENTIALS OF MOLYBDENUM IN FUSED EUTECTIC MIXTURES OF LITHIUM AND POTASSIUM CHLORIDES. Ryzhik, O. A.; Smirnov, M. V. Tr. Inst. Elektrokhim., Akad. Nauk SSSR, Ural. Filial, No. 8, 43-6(1966). (In Russian).

The equilibrium between molybdenum and fused eutectic mixtures of lithium and potassium chlorides, containing from 0.30 to 4.14 wt % Mo in the temperature interval from 500 to 860°C was investigated using the electromotive force method. It was shown that the standard electrode potential of Mo/Mo^{3+} depends linearly on the inverse size of the radius of the cation of the solvent salt in the series LiCl, 3LiCl–2KCl, KCl, and CsCl. It was established that the effective radius of the cation of the fused mixture 3LiCl–2KCl, satisfying the linear relation of $E^0_{Mo/Mo^{3+}}$ to $1/r_{Me^+}$, is somewhat larger than the mean weighted sizes. (tr-auth)

40842 TRIVALENT URANIUM PENTAFLUORIDE COMPLEX IN THE FLUORIDE–CHLORIDE MELT NaCl–KCl–NaF. Smirnov, M. V.; Koryushin, A. P.; Skiba, O. V. Tr. Inst. Elektrokhim., Akad. Nauk SSSR, Ural. Filial, No. 8, 47-54(1966). (In Russian).

It was established from current yields in the anode solution that in the fluoride–chloride melt in equilibrium with the metal, trivalent uranium primarily occurs. It was found that, in the equimolecular mixture NaCl–KCl with the ratio [F]/[U] > 14, trivalent uranium forms the complex UF_5^{2-} with the fluoride anion. An expression for the temperature dependence of the instability constant of the complex UF_5^{2-} lg K = 0.84–9800/T was found from the experimental data. The heat ΔH = 44.5 kcal/g·ion and entropy ΔS = –4.84 of the formation reaction of the pentafluoride complex of trivalent uranium in the fused medium NaCl–KCl were calculated. (tr-auth)

40843 RAPID REACTION RATES IN A URANYL ION HYDROLYSIS EQUILIBRIUM. Cole, David L.; Eyring, Edward M.; Rampton, Dennis T.; Silzars, Aris; Jensen, Ronald P. (Univ. of Utah, Salt Lake City). J. Phys. Chem., 71: 2771-5(Aug. 1967).

Rate constants for the uranyl nitrate equilibrium $UO_2^{2+} + H_2O \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} UO_2OH^+ + H^+$ in aqueous solution at 25° were determined by the dissociation field effect relaxation method. The specific rate k_{-1} = $1.65 \pm 0.33 \times 10^{10}$ M^{-1} sec^{-1} at an ionic strength $\mu \leq 4 \times 10^{-4}$ M. (auth)

40844 CARBON ISOTOPE EFFECTS IN THE DECOMPOSITION OF OXALIC ACID IN GLYCERINE SOLUTION. Buddenbaum, Warren E.; Haleem, M. A.; Yankwich, Peter E. (Univ. of Illinois, Urbana). J. Phys. Chem., 71: 2929-33(Aug. 1967).

The ^{13}C kinetic isotope effects in the decomposition of oxalic acid in glycerine solution were studied at 98 to 135°. Direct measurements were made of the intramolecular isotope effect; it was found to increase with increasing temperature, being about 1.2% at 98° and about 2.4% at 135°. Of the two derived intermolecular isotope effects, one is of the order of 1% and so strongly temperature dependent as to suggest inversion in sense near 200 to 250°, while the other is 2.5 to 3.0% and nearly (subject to considerable experimental error, however) independent of temperature. The results are examined in light of simplified calculations on eight-atom models and an analysis of abnormal temperature effects in kinetic isotope fractionation, both published previously. Neither the conventional nor the isotope kinetics results support a multiple-path mechanism; both are consistent with operation of the cross-over phenomenon in the temperature-dependent factors of the isotopic rate constant ratios—for which, however, there is as yet no direct evidence. (auth)

40845 ELECTRON SPIN RESONANCE INVESTIGATION OF THE REACTIONS OF HYDROGEN AND DEUTERIUM ATOMS IN ALKYLSTYRENE POLYMERS. Tiedeman, G. T.; Ingalls, R. B. (Atomics International, Canoga Park, Calif.). J. Phys. Chem., 71: 3092-5(Aug. 1967).

The reactions of thermal hydrogen and deuterium atoms with certain alkyl-substituted aromatic compounds were studied. In order to broaden the area for possible reactions in as small a volume as possible, polymeric analogs of the condensed sample were lyophylized to produce a fluffy material. Reactions were studied by allowing atoms to impinge on the large-surfaced material. The stabilized radicals were examined by ESR spectroscopy. Polymers of the following compounds were 3-methylstyrene, 3-(trideuteromethyl)styrene, and 4-isopropylstyrene. Results indicate that hydrogen atoms add to the aromatic ring of a simple alkyl aromatics rather than abstracting from the alkyl side chain. (J.G.B.)

40846 MECHANISM FOR THE ISOTOPIC EXCHANGE BETWEEN DEUTERIUM AND ACIDIC SOLUTIONS ON PALLADIUM SURFACES. Holleck, G. L.; Flanagan, Ted B. (Univ. of Vermont, Burlington). J. Phys. Chem., 71: 3110-11(Aug. 1967).

The isotopic content of the gas absorbed by palladium wire specimens when D_2 is bubbled through H_2O solutions was determined by mass spectrometric analysis of the gases evolved from the specimen following heating in vacuo. Appreciable exchange took place with specimens which were activated prior to an absorption run by palladization. In the presence of I^- the exchange was markedly reduced. Results indicate that in dilute acid media isotopic exchange occurs by an electrochemical mechanism. However, at higher pH values exchange mechanisms other than electrochemical are apparently involved. (J.G.B.)

40847 THE INFRARED SPECTRUM OF HOCl. Ashby, R. A. (New South Wales Inst. of Tech., Sydney). J. Mol. Spectros., 23: 439-47(Aug. 1967).

The ν_1 bands of HOCl and DOCl were examined under high resolution using a vacuum, grating infrared spectrometer. The following rotational constants were determined. For $HO^{35}Cl$: A'' = 20.46 ± 0.02 cm^{-1}, B'' = 0.5058 ± 0.0012 cm^{-1}, and C'' = 0.4922 ± 0.0012 cm^{-1}; for $HO^{37}Cl$: A'' = 20.46 ± 0.02 cm^{-1}, and B'' = 0.4902 ± 0.0015 cm^{-1}; for DOCl: A'' = 11.07 ± 0.04 cm^{-1}. The geometry of the HOCl molecule was found to be r(OH) = 0.97$_4$ ± 0.02 Å, r(OCl) = 1.689 ± 0.006 Å and ∠HOCl = 104°47' ± 5°. (auth)

40848 ESTIMATION OF HARMONIC FREQUENCIES OF D_2S, D_2Se, AND H_2Se TO EVALUATE QUADRATIC FORCE CONSTANTS. Gamo, Itaru (Univ. of Waseda, Tokyo). J. Mol. Spectros., 23: 472-5(Aug. 1967).

A study concerning the empirical estimation of the vibrational harmonic frequencies of D_2S, D_2Se, and H_2Se was made. The molecules are of the type XY_2. Calculations were completed for the molecules and the bending frequency of H_2Se was estimated. (D.H.M.)

40849 HYDROGEN BONDING IN SOME COPPER(II) AND NICKEL(II) VIC-DIOXIMES. Caton, John E. Jr.; Banks, Charles V. (Ames Lab., Iowa). Contract W-7405-eng-82. Inorg. Chem., 6: 1670-5(Sept. 1967). (IS-1557).

The infrared spectra of bis(2,3-butanedionedioximato-N, N') copper(II) [$Cu(DMG)_2$], bis(2,3-butanedionedioximato-N,N')-nickel (II) [$Ni(DMG)_2$], bis(2,3-pentanedionedioximato-N, N')nickel(II) [$Ni(EMG)_2$], and their deuterated analogs were investigated. The spectra of $Ni(DMG)_2$ and $Cu(DMG)_2$ in solution were also determined. Hydrogen bonding in the copper chelate was found to be

much stronger in solution than in the solid. On the basis of the infrared spectra and the reactivity with dimethyl sulfate, phenyl isocyanate, and acetic anhydride, it was concluded that hydrogen bonding in $Cu(DMG)_2$ rearranges on solution so that it is quite similar to the hydrogen bonding of the nickel chelates in the crystalline state. Thus, a shortening of the O–O distances in the copper chelate is predicted on solution. Finally, the study indicates the possibility that symmetrical hydrogen bonds occur for both nickel chelates in the crystalline state and that all three chelates have symmetrical hydrogen bonds in solution. (auth)

40850 ELECTROPHILIC SUBSTITUTION AT SATURATED CARBON. XXXIII. THE STEREOCHEMICAL FATE OF THE α-SULFONYLCARBANION IN WHICH BOTH ANION AND SULFONE GROUPS ARE INCORPORATED IN FIVE MEMBERED RING SYSTEMS. Cram, Donald J.; Whitney, Thomas A. (Univ. of California, Los Angeles). J. Amer. Chem. Soc., 89: 4651-61 (Aug. 30, 1967).

The stereochemical fate of the α-sulfonylcarbanion in which both anion and sulfone groups are incorporated in five-membered ring systems was examined. The base-catalyzed decarboxylations of (–)-2-methyl-2, 3-dihydrobenzothiophene-2-carboxylic acid 1-dioxide ((–)-I) to give 2-methyl-2, 3-dihydrobenzothiophene 1-dioxide (II) and of (+)-2-methyltetrahydrothiophene-2-carboxylic acid 1-dioxide ((+)-III) to give 2-methyl-tetrahydrothiophene 1-dioxide (IV) were carried out. Optically pure (+)-II was prepared by fractional crystallization of material obtained by decarboxylation of (–)-I (in water buffered with ammonium acetate). Similarly, optically pure (–)-II-d was prepared from (+)-I (in buffered deuterium oxide). That optical purity of II was reached was demonstrated by an isotopic dilution–reresolution experiment. Optically pure (+)-IV was prepared by decarboxylation of one of the four optically pure stereoisomers of 5-methyltetrahydrothiophene-2-carboxylic acid 1-dioxide (V). Values of k_e/k_α (one-point rate constant for isotopic exchange over that for racemization) for base-catalyzed reaction of optically active II in various media were determined. Results were: (+)-II-d in 91% dimethyl sulfoxide–9% methanol–potassium methoxide at 25°C gave $K_e/K_\alpha = 0.64$ (–)-II-d in 70% t-butyl alcohol–30% tetrahydrofuran–potassium t-butoxide at 25°C gave $k_e/k_\alpha = 0.66$; (–)-II-d in methanol–potassium methoxide at 76°C gave $k_e/k_\alpha = 0.64$; (+)-II-h in methanol-O-d potassium methoxide at 76°C gave $k_e/k_\alpha = 0.65$. These isotopic exchange reactions occurred with considerable net inversion of configuration. In the run made in t-butyl alcohol–tetrahydrofuran, the partially racemized product was reresolved, and the deuterium content of each enantiomer determined. The kinetic isotope effect for racemization of optically active II under the same conditions was shown to be $k^H/k^D = 1.3$. From these data, the relative rates of three stereochemical processes were extracted: inversion without exchange; net inversion with exchange; racemization with exchange. A conducted tour mechanism for the two inversion processes was formulated. In this mechanism, both carbanion and potassium ion (and ligand) rotations within contact ion pairs are envisioned as occurring without complete breaking of $C^- \ldots$ HOR hydrogen bonds. The stereochemical direction of decarboxylation of salts of (–)-I was studied. The product varied from (–)-II of 3% optical purity in t-butyl alcohol to (±)-II in dimethyl sulfoxide to (+)-II of 65% optical purity in water. An assignment of stereochemical course to these reactions is suggested based on the similarity between the pattern of results obtained in this and other systems. Decarboxylations of (+)-III gave IV with stereospecificities and solvent dependence similar to that observed with its benzo analog. In both the decarboxylations and isotopic exchange reactions, the results point to symmetrical (planar) α-sulfonylcarbanions in asymmetric environments as discrete reaction intermediates. (auth)

40851 ELECTROPHILIC SUBSTITUTION AT SATURATED CARBON. XXXIV. ISOINVERSION AS A MECHANISTIC COMPONENT IN BASE-CATALYZED HYDROGEN–DEUTERIUM EXCHANGE BETWEEN CARBON ACIDS AND MEDIUM. Ford, Warren T.; Graham, Edward W.; Cram, Donald J. (Univ. of California, Los Angeles). J. Amer. Chem. Soc., 89: 4661-9 (Aug. 30, 1967).

Analysis of the over-all stereochemical course of base-catalyzed hydrogen–deuterium exchange reactions of carbon acids in terms of mechanistic components is provided by a kinetic model. Rate constants for exchange with retention of configuration, exchange with inversion, and isoinversion (defined as inversion without exchange) were determined for exchange of N, N, 9 trimethylfluorine-2-carboxamide (I) I-H_+ in methanol-O-d with potassium methoxide at 25°C by two experimentally independent methods based on the model. One method used only kinetics, and the other used reresolution of partially racemized material. Exchange of I-D_+ in t-butyl alcohol with potassium phenoxide was also investigated by the latter method. Isoinversion was shown to be a contributing mechanistic component in both media. Primary substrate and solvent isotope effects on racemization of I are reported. The results are interpreted by a mechanism in which carbanions are tightly hydrogen bonded to just one solvent molecule at a time. (auth)

40852 STUDIES ON ELECTROLYTIC SUBSTITUTION REACTIONS. III. ISOMER DISTRIBUTIONS AND ISOTOPE EFFECTS IN NUCLEAR AND SIDE-CHAIN ANODIC ACETOXYLATION OF AROMATIC COMPOUNDS. Eberson, Lennart (Univ. of Lund, Sweden). J. Amer. Chem. Soc., 89: 4669-77(Aug. 30, 1967).

Using the determination of isomer distributions as an experimental tool, the anodic acetoxylation of representative aromatic compounds in acetic acid–acetate was investigated with respect to a number of experimental variables, such as the influence of changing the anode potential, the nature of the cation, and the concentration of the acetate ion. As regards the nature of the anion, it was found that the presence of acetate ion is essential for nuclear acetoxylation to occur. A concerted mechanism, involving a two-electron transfer from the π-electron system of the aromatic compound simultaneously with the formation of a C–O bond to an acetate ion, is proposed for this reaction. This type of mechanism is closely similar to that generally assumed to be valid for electrophilic aromatic substitution reactions. Results from isomer distribution studies for anodic nuclear acetoxylation of a number of simple aromatic compounds confirmed the validity of this analogy, as did isotope effect determinations. In sharp contrast to nuclear acetoxylation, it was found that side-chain acetoxylation of alkylaromatic compounds can also be achieved in acetic acid containing salts of other anions, such as perchlorate and tosylate. For side-chain acetoxylation of ethylbenzene an isotope effect $k_H : k_D$ of 2.6 ± 0.3 was determined. The similarity between the product distributions of anodic and manganic acetate acetoxylation of p-methoxytoluene further supported the view that benzyl cations are intermediates in side-chain acetoxylation, although existing data do not allow a differentiation between different mechanisms for their formation. (auth)

40853 THE TRANSITION STATE FOR BASE-CATALYZED CLEAVAGE OF THE SILICON–OXYGEN BOND. Schowen, Richard L.; Latham, Kenyon S. Jr. (Univ. of Kansas, Lawrence). J. Amer. Chem. Soc., 89: 4677-83(Aug. 30, 1967).

Substituent correlations and solvent isotope effects were examined for the general base-catalyzed methanolysis of aryloxytriphenylsilanes, previously shown to follow a protolytic mechanism. The solvent isotope effects for p-chlorophenoxytriphenylsilane are $k_H/k_D = 1.25 \pm 0.06$ (acetate ion catalysis) and 1.35 ± 0.06 (methoxide ion catalysis), consistent with "solvation-rule" behavior. Curvature in the free-energy relations for leaving-group structural variation was analyzed and tentatively interpreted in terms of π bonding of the leaving group to silicon in the activated complex or of a change in mechanism with substituent. (auth)

40854 PRIMARY AND SOLVENT ISOTOPE EFFECTS IN THE ANODIC EVOLUTION OF OXYGEN. Salomon, Mark (Rutgers–The State Univ., New Brunswick, N. J.). J. Electrochem. Soc., 114: 922-6(Sept. 1967).

The use of H_2 isotopes in studying the O_2 evolution reaction (o.e.r.) is discussed. It is shown that along with other experimental data such as pH studies, Tafel behavior, etc., the H/D-isotope effects can be used as additional criteria for the elucidation of reaction mechanisms. Normal isotope effects, i.e., those corresponding to the o.e.r. being faster in H_2O than in D_2O, arise normally from considerations of the primary isotope effect. Depending on the magnitude of the solvent isotope effect, several cases involving an inverse isotope effect arise, i.e., the rate of the o.e.r., is faster in D_2O than it is in H_2O. A treatment of these isotope effects is presented and experimental data for the o.e.r. at Ni anodes are discussed. (auth)

40855 THE PREPARATION AND ELECTRICAL RESISTANCE OF SINGLE CRYSTALS OF β-US_2. Smith, P. K.; Cathey, L. E. I. Du Pont de Nemours and Co., Aiken, S. C.). J. Electrochem. Soc., 114: 973-5(Sept. 1967). (DP-MS-67-24).

The vapor-transport technique was used to form small single crystals of orthorhombic β-US_2. Polycrystalline US_2 was reacted with iodine at 940°C, and the gaseous uranium iodide and sulfur were transported down a temperature gradient and deposited at 700°C as single crystals of β-US_2. Resistance-temperature measurements on the β-US_2 crystals indicated that the crystals are semiconductors with a low activation energy for charge carrier generation. (M.C.G.)

40856 INFRARED SPECTRA OF SOME URANYL NITRATE COMPLEXES. Bullock, J. I. (Univ. of Surrey, London). J. Inorg. Nucl. Chem., 29: 2257-64(Sept. 1967).

The preparative methods for a number of uranyl nitrate complexes were investigated. The ir spectra of these complexes are

consistent and all show the presence of bidentate nitrate groups. No relationship between the asymmetric stretching frequency of the uranyl ion and the position of particular ligands in the spectrochemical series could be detected. (auth) (UK)

40857 ISOTOPE EXCHANGE REACTIONS OF LIGANDS IN TETRAHEDRAL COMPLEXES. SYSTEM: $(C_2H_5)_2$ $TiCl_2$–$Li^{36}Cl$. Schiavon, Gaetano; Paradisi, Carmen (Univ., Bologna. Univ., Padua. CNR, Padua). Ric. Sci., 37: 337-41(Apr. 1967). (In Italian).

Results obtained in the study of isotopic exchange between $(C_5H_5)_2$ $TiCl_2$–LiCl are reported. The exchange measurements were made in the following solvents: dimethylformamide, anhydrous acetone, and tetrahydrofuran. In dimethylformamide the exchange was complete in the time of separation of the reagents at low concentration and in the interval 5 to 25°C. From a kinetic study of the exchange in tetrahydrofuran energy and entropy values were obtained, while the fact that the rate was independent of the LiCl concentration permitted a probable mechanism of reaction to be calculated. (auth)

40858 STUDIES OF PHOTOLUMINESCENCE OF AQUEOUS URANYL NITRATE SOLUTIONS IN THE PRESENCE OF SODIUM TETRAMETAPHOSPHATE. Dombrovskii, N. M.; Guminetskii, S. G.; Sorochenko, L. T.; Shapovalenko, O. I. Zh. Prikl. Spektrosk., Akad. Nauk BSSR, 6: 654-6(May 1967). (In Russian).

The photoluminescence of $UO_2(NO_3)_2$ solutions (I) at concentrations from 10^{-5} to 5×10^{-2} mol/l in the presence of $Na_4P_6O_{12}$ (II) at concentrations of 2 wt % was investigated. The mixture was exposed to uv light in the region from 3200 to 3800 Å. For determination of the intensity of the photoluminescence, a photomultiplier was used. The absorption and luminescent spectra of the tetrametaphosphate uranyl complex in the solution were measured. The luminescent spectrum was found in a narrow region and was characterized by three maxima at 4910, 5150, and 5400 Å. The difference in the configuration of the tetrametaphosphate anions showed no effect on the luminescent spectrum; the spectra of solution I in the presence of II were identified in the "chair" and "boat" form. (tr-auth)

40859 SYNTHESES AND RADIOCRYSTALLOGRAPHIC STUDY OF SYNTHETIC URANATES OF THE DOUBLE URANYL OXIDE TYPE. Peters, J.-M. Mem. Soc. Roy. Sci. Liege(8), 14: 9-57 (1967). (In French).

A method for the synthesis of double uranyl oxides capable of furnishing monocrystals was developed. The synthesis was carried out in sealed tubes at temperatures above 100°C and with a rigorous regulation of the initial pH. The slowing down of the hydrolysis of the solution is favorable to the formation of monocrystals. The precipitates obtained were identified by Debye-Scherrer diagrams. In addition, chemical analyses were made and the properties were determined. Diuranates, triuranates, $0.9SrO \cdot 3UO_3 \cdot 4.2H_2O$, billietites, schoepite, the $2XO \cdot 5UO_3 \cdot 3H_2O$ group (where X is Pb, Ba, or Sr), the hydrated oxides $UO_2(OH)_2$, and the silicates were synthesized. The crystallographic parameters of each precipitate were determined and the results tabulated. The physical and chemical properties of the double oxides were interpreted on the basis of the hypothesis of H. Brasseur. There was evidence of oxonium, H_3O^+, in the compounds corresponding to the Brasseur hypothesis. (J.S.R.)

40860 ATOM-MOLECULE KINETICS USING ESR DETECTION. II. RESULTS FOR $D + H_2 \rightarrow HD + H$ AND $H + D_2 \rightarrow HD + D$. Westenberg, A. A.; de Haas, N. (Johns Hopkins Univ., Silver Spring, Md.). J. Chem. Phys., 47: 1393-1405(Aug. 15, 1967).

The wide-temperature-range, fast-flow kinetic system with ESR atom detection was used to measure rate constants for the isotopic reactions $D + H_2 \rightarrow HD + H$ and $H + D_2 \rightarrow HD + D$ over the range 250 to 750°K and 300 to 750°K, respectively. The precision of the data at a given temperature is about ±5%, except at the lowest temperature in each case where it is ±8%. It is believed that this also represents the accuracy. In the range 450 to 750°K both sets of data are Arrhenius linear and obey (cubic centimeters $mole^{-1} \cdot second^{-1}$): $k_1 = 4.4 \times 10^{13} \exp(-7610/RT)$; $k_2 = 4.9 \times 10^{13} \exp(-9390/RT)$. Interpretation of the linear portion is made in terms of absolute rate theory with no tunneling. A potential-energy surface constructed by fitting the experimental activation energies by the Sato method as described by Weston is in essential agreement with the latter's results for the H_3 complex. The properties of the complex give pre-exponential factors in satisfactory agreement with experiment. The experimental ratio k_1/k_2 in the linear region is closely predicted simply by the limiting form using the ratio of collision frequencies and the zero-point energy difference between H_2 and D_2. It is shown that data in the nonlinear region below 450°K give apparent "tunnel corrections" τ for the two reactions that are qualitatively of the form $\tau_1 < \tau_2$, while all theories predict $\tau_1 > \tau_2$. (auth)

40861 DESCRIPTION OF AMMONIUM DIURANATE PRODUCED IN THE PILOT PLANT AT KALNA. Jovanovic, Dura; Milosavljevic, Jovan. (Inst. for Nuclear Raw Materials, Belgrade). Tehnika (Belgrade), No. 9, 1530-6(1966). (In Slovak).

The thermal decomposition of ammonium diuranate (ADU) was investigated using thermogravimetric analysis (TGA) in the 20 to 900°C range. All the TGA experiments were carried out on a Stanton thermobalance having ±0.001-g sensitivity. On continuous heating from 20 to 120°C at a rate of 5°C/min, ADU loses moisture. Crystalline water loss takes place at 120 to 200°C. Gaseous NH_3 evolution begins at 270°C and ceases at 450°C. A plateau from 450 to 570°C and a negligible loss of weight is characteristic of pure UO_3. Further loss of O_2 according to the reaction $UO_3 \rightarrow U_3O_8$ takes place at 570 to 675°C. No change in weight was noticed at 675 to 900°C. Chemical analysis, differential thermal analysis, and x-ray diffraction were used for correct determination of ADU composition. It was concluded that ADU-Kalna has the following composition: $(NH_3)_{0.4}UO_3 \cdot 7H_2O$ (70 to 80%) and $UO_3 \cdot nH_2O$ (20 to 30%). In addition, the kinetics of the chemical processes taking place during thermal decomposition were also interpreted mathematically. (JPRS)

40862 INVESTIGATIONS ON CATALYTIC DEHYDRATION ON FINELY DIVIDED α-BORON. Becher, H. J.; Marosi, L. (Technische Hochschule, Stuttgart). Z. Anorg. Allg. Chem., 352: 206-19(1967). (In German)

The preparation of a finely divided form of α-boron, which is suitable for catalytic reactions, is described. This form was investigated with regard to the surface by physical and chemical methods. Formic acid and alcohols are dehydrated by this catalyst. The rates of these reactions were determined as a function of temperature and transport rate. The catalytic efficiency of α-boron was surprisingly high. This may be accounted to an increased activation of adsorbed molecules at neighboring BOH groups on the surface of the catalyst. Especially the CH bonds of methyl groups are activated by the catalyst as was shown by dehydration of partially deuterated 2-propanol and H–D exchange between propene and D_2O. (auth)

40863 THE EXCHANGE OF GASEOUS DEUTERIUM WITH THE PRODUCTS OF METHANOL ADSORPTION ON OXIDE CATALYSTS. Novakova, J.; Jiru, P.; Zavadil, V. (Inst. of Physical Chemistry, Prague). Collect. Czech. Chem. Commun., 32: 2439-47(July 1967).

The isotope exchange of gaseous deuterium was measured with the following oxides: Fe_2O_3, MoO_3, Fe_2O_3–MoO_3, Al_2O_3, and ZnO. The exchange was investigated with both oxides treated at elevated temperatures in vacuo and those having preadsorbed methanol. Fe_2O_3, Al_2O_3, and ZnO contain, even after vacuum treatment, a considerable amount of OH groups whose presence makes it impossible to follow the exchange of deuterium with preadsorbed methanol on Al_2O_3. The catalysts Fe_2O_3–MoO_3 and pure Fe_2O_3 with presorbed methanol liberate desorption products before the isotope exchange reaction starts. MoO_3 adsorbs only a small amount of methanol so that exchange is not measurable. ZnO with presorbed methanol exchanges hydrogen of the hydroxyl group already at room temperature provided that the amount of methanol adsorbed is smaller than monolayer. (auth)

40864 URANYL COMPLEXES WITH PHENOLIC LIGANDS. IX. POLAROGRAPHIC STUDIES OF THE COMPLEXES WITH KOJIC ACID. Hala, J. (Purkyne Univ., Brno). Collect. Czech. Chem. Commun., 32: 2565-72(July 1967). (In German).

Complexes of UO_2^{2+} and UO_2^+ with kojic acid were investigated polarographically in a formate buffer at pH < 5 and an ionic strength of 1.0($NaNO_3$). Under these conditions the complexes UO_2Ko^+ ($\log \beta = 7.27$), UO_2Ko ($\log \beta = 4.4$ to 5.4) and the mixed complex $UO_2KoHCOO$ ($\log \beta = 8.84$) were formed. (tr-auth)

40865 ELECTRON AFFINITY OF ASTATINE. Gopal, Vishnu (Meerut Coll., India). Curr. Sci. (India), 36: 456-7 (Sept. 5, 1967).

Observed and calculated electron affinities are given for F, Cl, Br, I, and At. It is shown that atoms of these elements obey the relation $E_A = 1.109 \times 10^{-3}\ \omega_{AA}\mu_{AA}^{0.6215}$, where E_A is electron affinity, ω_{AA} the vibrational constant of the corresponding homonuclear diatomic molecule, and μ_{AA} the reduced mass of the molecule in amu. (M.C.G.)

40866 INVESTIGATIONS INTO A POSSIBLE ^{14}C ISOTOPE EFFECT IN PHOTODISSOCIATIONS. Schutte, L.; Havinga, E. (Univ. of Leiden). Tetrahedron, 23: 2281-4(May 1967).

The photo-Fries rearrangement of p-methoxyphenylacetate-carboxyl-^{14}C and the photodecarboxylation of p-nitrophenylacetic acid-carboxyl-^{14}C were investigated to evaluate a possible ^{14}C isotope effect. In both cases k_{12}/k_{14} was found to be unity within experimental error. This is in agreement with the concept that

in many photochemical processes in solution the reaction, starting from the electronically excited state, occurs as a kind of internal conversion to the ground state of the primary product. No activation energy is needed in the sense of that encountered in thermal reactions. (BBB)

40867 BEHAVIOR OF URANIUM CARBIDES AT HIGH TEMPERATURES. I. THE OXIDATION OF URANIUM MONOCARBIDE. Sudo, Kingo; Osawa, Masaru (Tohoku Univ., Sendai). Nippon Genshiryoku Gakkaishi, 9: 372-5(July 1967). (In Japanese).

The oxidation of uranium monocarbide was investigated at moderate temperatures at various partial pressures of oxygen from 5 to 152 mm Hg. The oxidation of uranium monocarbide began between 225 and 250°C with a slight dependence on the oxygen pressure. Analysis of the oxidation curves and x-ray diffraction patterns indicated that the final product U_3O_8 was formed in one step. The data agree well with the expression representing rate-controlling reaction at the surface: $(1 - c)^{\frac{1}{3}} = 1 - kt$, where c is the fraction of oxidation in time t, and k the reaction rate constant. The activation energy for the oxidation process is 5.0 kcal/mol for low oxygen partial pressures (5 to 10 mm Hg). (auth)

40868 PREPARATION OF URANIUM AND THORIUM PHOSPHIDES. Adachi, Hirohiko; Imoto, Shosuke (Osaka Univ.). Nippon Genshiryoku Gakkaishi, 9: 381-5(July 1967). (In Japanese).

Uranium phosphides were prepared by direct reaction of uranium with red phosphorus vapor. Formation of U_3P_4 began at 430°C, and the optimum temperature for the reaction was found to be 450°C. By successive decomposition of U_3P_4 in vacuum at 1,050°C, monophase UP was obtained. Thorium phosphides were prepared by the same method. The composition of ThP obtained by the decomposition of Th_3P_4 was determined by chemical analysis to be $ThP_{0.62}$. By heating $ThP_{0.62}$ and some Th–$ThP_{0.62}$ mixtures to higher temperatures, monophosphides with lower contents of phosphorus were obtained. The monophase range of ThP_x was estimated to be about $ThP_{0.4-0.7}$. From x-ray analysis, a complete solid solution was found to be formed between UP and ThP, and the lattice parameter of the solid solutions followed Vegard's law with a slight positive deviation. (auth)

40869 RAMAN AND INFRARED SPECTRA OF THE $^{10}BF_3$ AND $^{11}BF_3$ COMPLEXES WITH DIMETHYL SULFIDE AND THE ISOTOPIC EXCHANGE OF THIS COMPLEX WITH BF_3. Begun, G. M.; Palko, A. A. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. J. Chem. Phys., 47: 967-70(Aug. 1, 1967). (ORNL-P-2964).

The Raman and infrared spectra of liquid BF_3·dimethyl sulfide were recorded for both the ^{10}B and ^{11}B compounds. Assignments of the observed bands were made using analogies with those of BF_3·dimethyl ether. The isotopic data were used to calculate theoretical equilibrium constants for isotopic exchange between the complex and BF_3. The calculated values are compared with published experimental values. (auth)

40870 DEUTERIUM ISOTOPIC DISPROPORTIONATION REACTIONS: THE AMMONIA SYSTEM AS STUDIED WITH A PULSED-MOLECULAR-BEAM MASS SPECTROMETER. Pyper, J. W.; Newbury, R. S.; Barton, G. W. Jr. (Univ. of California, Livermore). J. Chem. Phys., 47: 1179-82(Aug. 1, 1967).

Deuterium disproportionation equilibria in the ammonia system were studied at 0 and 25°C with a pulsed-molecular-beam mass spectrometer. The equilibrium constant for the reaction $NH_3 + ND_3 = NH_2D + NHD_2$ was found to be 8.29 ± 0.25 at 0° as compared with the statistical value of 9. The experimental results are shown to be consistent with theoretical calculations and similar measurements in the water system. (auth)

40871 SOLVENT EFFECT ON THE KINETICS OF ISOTOPIC EXCHANGE AT AROMATIC CARBON ATOM. I. IODINE EXCHANGE IN ACETONE–WATER MIXTURES. Marcopoulos, Ch. A. (Nuclear Research Center Democritus, Athens). Z. Phys. Chem. (Leipzig), 234: 297-304(Feb. 1967).

The effects of dielectric constant of the solvent on the order of the isotopic exchange between 1-iodo-2,4-dinitrobenzene or 1-iodo-2,4-dinitronaphthalene and KI labeled with ^{131}I were studied. Runs were carried out at 45°C with various concentrations of iodides and over a wide range of water percentage in acetone – water mixtures. To follow the increasing activity of the organic compound a liquid scintillation technique has been adopted. Rates and the order of the reaction in respect to iodides are reposted. (auth)

40872 BOND AND MOLECULAR POLARIZABILITIES, MEAN AMPLITUDES OF VIBRATION AND THERMODYNAMIC FUNCTIONS OF THORIUM OXIDE AND ZIRCONIUM OXIDE. Nagarajan, G. (Univ. of Maryland, College Park). Z. Phys. Chem. (Leipzig), 234: 406-18(Feb. 1967).

The bond and molecular polarizabilities have been calculated for thorium oxide and zirconium oxide possessing a bent symmetrical structure by the Lippincott-Stutman method employing the delta function model of chemical binding. The calculated values of molecular polarizabilities are in good agreement with those of experimental ones. The mean-square amplitude quantities, generalized mean-square amplitudes (mean-square parallel amplitudes, mean-square perpendicular amplitudes and mean cross products), and mean amplitudes of vibration for the bonded as well as nonbonded atom pairs have been evaluated at the temperatures T = 298°K and T = 500°K by the Cyvin method. The statistical thermodynamic functions have also been computed for the temperature range 500 to 5000°K on the basis of a rigid rotator, harmonic oscillator model. (auth)

40873 PROCEEDINGS OF THE INTERNATIONAL CLAY CONFERENCE, 1966, JERUSALEM, ISRAEL, JUNE 20–24, 1966. VOLUME II. Heller, L. (ed.). Jerusalem, Israel Program for Scientific Translations, 1967. 336p. (CONF-660601-(Vol.2); IPST-10266).

Twelve additional papers on the same subject breakdown are included in this volume along with discussion on the papers that are included in Vol. I. None of the twelve papers were included in NSA. (P.C.H.)

40874 PROCEEDINGS OF THE INTERNATIONAL CLAY CONFERENCE, 1966, JERUSALEM, ISRAEL, JUNE 20–24, 1966. VOLUME I. Heller, L.; Weiss, A. (eds.). Jerusalem, Israel Program for Scientific Translations, 1966. 446p. (CONF-660601-(Vol.1); IPST-10192).

Forty-two papers are included; one paper on development and applications of minerals in radioactive waste disposal was previously abstracted in NSA as 20: 29332. The remaining forty-one papers contain information on: nomenclature, structural properties, and composition of clay minerals; origin and geochemistry of clays; clay-organic compounds; colloidal properties of clay minerals; physical methods in clay research; and industrial applications of clays and clay minerals. (P.C.H.)

40875 HIGH-TEMPERATURE CHEMISTRY. CURRENT AND FUTURE PROBLEMS. A Conference Organized at Rice University, Houston, Texas, January 26–27, 1966. Publication 1470. Washington, D. C., National Academy of Sciences–National Research Council, 1967. 105p. $3.00. (CONF-660106).

Topics covered include: spectroscopy of high-temperature molecules, applications of molecular-beam techniques to high-temperature chemistry, high-temperature molecules, re-entry ablation and wake chemistry of polymers and refractories, condensed-phase microspecimens at high temperatures, problem areas in high-temperature chemistry, containment of liquid metals, periodic compounds, vapor-solid transformations, gas-solid reactions in flow environments, chemistry of hot and cold plasmas, high-temperature high-pressure research, high-temperature phase equilibria, and properties of refractory metal oxides. (M.C.G.)

40876 INTERNATIONAL SYMPOSIUM ON MACROMOLECULAR CHEMISTRY, PRAGUE, 1965. PART 3. Held Under the Auspices of the International Union of Pure and Applied Chemistry, Prague, August 30–September 4, 1965. Wichterle, O.; Sedlacek, B. J. Polym. Sci., Part C, No. 16, 1231-1856 (1967). (CONF-650801-(Pt.3)).

Fifty-six papers presented at the conference are included. A separate abstract was prepared for one paper. (M.C.G.)

For an abstract of the individual paper see: 40926.

Radiation and Nuclear Chemistry

Refer also to abstracts 40772, 40813, 40825, 40935, 41292, 41348, 41556, 41791, 42545, and 42582.

40877 (AERE-C/R-2669) LIGHT EMISSION FROM GASES IRRADIATED WITH X RAYS. Brocklehurst, B. (Atomic Energy Research Establishment, Harwell (England)). Dec. 1963. 73p. Dep. CFSTI, UK.

The emission spectra between 2000 and 7000A excited in gases by x rays have been photographed and the intensities of individual bands measured with a photomultiplier at pressures between 1 and 700 mm. The long range of the secondary electrons gives a complicated energy absorption characteristic. Carbon dioxide shows emission from CO_2^+ while nitrogen gives the first negative (N_2^+) and second position (N_2) band systems. The change in vibrational temperature with pressure has been studied in the latter system.

Nitrous oxide emits the β bands of nitric oxide and some previously unknown bands which are ascribed to N_2O^+. Nitric oxide, alone and in mixtures, gives a very feeble emission, probably due to the chemiluminescent reaction $NO + O \rightarrow NO_2 + h\nu$. The inert gases show a remarkable change from line spectra only, in neon, to continua in xenon; added gases are readily excited by the long-lived metastable states of the inert gases. 73 references. (auth)

40878 (BNL–11294) REVIEW OF INDUSTRIAL RADIATION CHEMISTRY IN THE UNITED STATES. Manowitz, B. (Brookhaven National Lab., Upton, N. Y.). Apr. 1967. 37p. (CONF-670906–1). Dep. CFSTI.

From Symposium in Association with the Institute of Chemical Engineers and the Royal Institute of Chemistry, London, England.

Developments in industrial radiation chemistry and their current status and future possibilities are discussed. The major use of radiation in industrial chemistry is the radioinduced polymerization and crosslinking of polyethylene using electron beams. One use of gamma radiation is the production of a sodium alkanesulfonate (SAS) biodegradable detergent. Design parameters in applied radiation chemistry are also discussed. (P.C.H.)

40879 (BNL–11550) RADIATION FACILITY FOR USE WITH HAZARDOUS CHEMICAL SYSTEMS. Huszagh, D. W.; Kukacka, L. E.; Steinberg, M. (Brookhaven National Lab., Upton, N. Y.). [nd]. 13p. (CONF-671102–7). Dep. CFSTI.

For Presentation at 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill.

Two recessed gamma radiation cells were designed and constructed specifically for use with highly combustible gases at high pressures. Criteria for the design of the facility, which could be used for the synthesis and production of chemicals, included: the reduction of the possibility of an explosion to a minimum; limitation of the degree of pressure buildup contingent to an explosion; and the enhancement of the probability that radiation sources will remain shielded and be safely recoverable in the event of an explosion. The cell protective system was designed for experiments containing up to 1 liter of ethylene gas at a pressure of 2000 atm and 20°C (590 grams). Tests showed that the architectural features and supplemental protective systems allowed the use of quantities in excess of that required to exceed the explosive limit. (J.G.B.)

40880 (CONF-670542–, Paper 10) TRANSURANIUM ELEMENTS AS BYPRODUCTS OF NUCLEAR FUEL REPROCESSING. Overbeck, W. P. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). 16p.

The transuranium isotopes of principal interest are ^{238}Pu, ^{244}Cm, and ^{252}Cf. Substantial quantities of these isotopes can be obtained as byproducts of the nuclear power industry if the necessary recovery facilities are provided. These quantities can be considerably enhanced through recycling of uranium and plutonium fuels. Within the next 10 years, large-scale production of ^{238}Pu and ^{244}Cm could be achieved. If an adequate market can be developed, the production of these transuranium isotopes could result in significant long-term savings in the cost of nuclear power. (auth)

40881 (NP-16645) CHEMISCHE REAKTIONEN BEI DER γ-BESTRAHLUNG VON PHOSPHORTRICHLORID IM GEMISCH MIT POLYMERISIERBAREN OLEFINEN. (Chemical Reactions in the γ-Irradiation of Phosphorus Trichloride in Mixtures with Polymerizable Olefins). Renz, Manfred (Technische Universitaet, Berlin (West Germany). Fakultaet fuer Allgemeine Ingenieurewissenschaft). 1967. 62p. (In German). Dep.

Thesis.

The reactions of phosphorus trichloride, cyclohexylphosphorus dichloride, and dicyclohexylphosphorus chloride with styrene, of phosphorus trichloride with a-methylstyrene, and of phosphorus trichloride with isobutene under the effects of γ radiation and heat were investigated. In the radiochemical polymerization of styrene, phosphorus trichloride reduce the molecular weight and the gross reaction velocity; cyclohexylphosphorus dichloride and dicyclohexylphosphorus chloride increases the polymerization velocity significantly. α-methylstyrene which polymerizes only ionically as the pure monomer reacted in the presence of PCl_3 by a radical mechanism. The polystyrene formed in the presence of phosphorus trichloride contained chemically bound phosphorus. In purely thermal chain initiation, products with very low phosphorus content arose. By variation of the research conditions (dose output, temperature, and concentration) phosphorus containing polystyrene with varying molecular weight and phosphorus content can be prepared. The phosphorus content of the polymers reduced their flamability. Isobutene did not polymerize in the presence of phophorus trichloride. 1-di-chlorophosphinyl-2-chloro-2-methylpropane and 2-dichlorophosphinyl-1-chloro-2-methylpropane were produced by a radical chain mechanism as the principal product. Because of the high G-values a chain reaction was assumed. The mechanism of this chain reaction is discussed. (tr-auth)

40882 (NYO–3570-3) RADIATION CHEMISTRY OF SILANE SYSTEMS. Interim Progress Report. Lampe, F. W. (Pennsylvania State Univ., University Park). Apr. 1, 1967. Contract AT-(30-1)-3570. 15p. Dep. CFSTI.

Studies on the gamma radiolysis of pure silane and the gamma radioinduced telomerization of monosilane with ethylene are described. The yields and mechanisms for the formation of H_2 and Si_2H_6 in the gamma radiolysis of pure silane are discussed. The effects of nitric oxide, surfaces, xenon, and ethylene on the yields were also investigated. When 5 : 1 mixtures of $SiH_4-C_2H_4$ were irradiated, four major products were found. Besides H_2 and Si_2H_6, the others were $CH_3CH_2SiH_3$ and $(CH_3CH_2)_2SiH_2$. The effects of surface and nitric oxide on the telomerization reactions are discussed along with the mechanism for the reaction. Preliminary investigations of ion-molecule reactions in SiH_4-CH_4 indicated the formation of $CSiH_5^+$ ions. (P.C.H.)

40883 THE CORRELATION OF THE OVERALL RATE CONSTANT TO THE DOSE INTENSITY IN THE KINETIC EQUATION FOR RADIO-OXIDATION OF CYSTINE IN AQUEOUS SOLUTIONS. Brdicka, R.; Fojtik, A. (Inst. of Physical Chemistry, Prague). Collect. Czech. Chem. Commun., 32: 3024–8(Aug. 1967).

Two experiments were carried out to obtain the values of the overall rate constant in an extended range of dose intensities. In one of them, the decrease in cystine concentration was followed with time for different initial concentrations and dose intensities. Solutions of 10^{-4}, 5×10^{-4}, and 10^{-3}M cystine were γ-irradiated with intensities of 7.32×10^{15}, 9.15×10^{15}, and 6.4×10^{15} eV $ml^{-1}sec^{-1}$, respectively. Deviations from former observations with doses above 2×10^{18} eV/ml disappeared when the oxygen consumed in the radio-oxidation process was replaced by stopping the irradiation at intervals and stirring the sample in open air. The second set of experiments varied dose intensity with time of irradiation in such a way that the product remained approximately constant. Results indicated that for a chosen dose, the product is independent of the intensity. This relation is expressed by $k = 1.94 \times 10^{-21}(mol/l)^{\frac{1}{2}}$ $(eV/ml)^{-1}$. (P.C.S.)

40884 EXPERIMENTAL INVESTIGATION OF THE DISSOCIATION OF EXCITED IONS. Karachevtsev, G. V.; Talroze, V. L. (Inst. of Chemical Physics, Moscow). Kinet. Kataliz, 8: 447–50(Mar.–Apr. 1967). (In Russian).

The method of ionization by electrons in a strong electric field was used for measuring the velocity of the decay of ions produced by ionization of ethylene, ethane, n-hexane, and toluene by electrons at 2 keV. It was found that the principal share of the decay of the excited ions occurs in less than 10^{-9} to 10^{-10} sec, but in a series of cases during ionization of complex molecules delayed decays were observed. It was concluded that utilization of the usual mass spectra for calculating the mechanism of complex radiation chemical reactions at high pressures is not always permissible. (tr-auth)

40885 THE BEHAVIOUR OF RECOIL ATOMS IN POTASSIUM CHROMATE DOPED WITH BARIUM. Costea, T.; Podeanu, G. (Inst. of Atomic Physics, Bucharest). J. Inorg. Nucl. Chem., 29: 2102–6(Aug. 1967). (In French).

Samples of barium-doped potassium chromate were irradiated with various neutron doses in the core and thermal column of the IFA reactor, and examined to find the initial retention and effects of annealing at various temperatures. Previous nonreproducibility of results is explained by different irradiation conditions and different activation energies. (UK)

40886 CHARACTERISTICS OF RADICAL FORMATION IN LOW TEMPERATURE RADIOLYSIS OF BENZOYL PEROXIDE. Chkeidze, I. I.; Trofimov, V. I.; Koritskii, A. T. (Inst. of Chemical Physics, Moscow). Kinet. Kataliz, 8: 453–6(Mar.–Apr. 1967). (In Russian).

The low-temperature radiolysis of benzoyl peroxide was investigated by the EPR method and mass spectrometry. It was determined that the principal gaseous product of the radiolysis was CO_2, the yield of which was 6.4 l/100 eV. The H_2 yield was 0.15 l/100 eV. Along with the basic primary radicals, phenyl radicals also appear. The secondary reactions of these radicals exist in addition to the ring of the primary molecules in the para position with respect to the substitute. It was found that during radiolysis of benzoyl peroxide two radicals are formed from one molecule because of the splitting of CO_2. It is analogous to the formation of radicals in azobenzene where two radicals are formed because of the splitting of N_2 molecules. (tr-auth)

40887 THE CHEMISORPTION OF H_2 AND O_2 BY Zn AND Al OXIDES UNDER THE INFLUENCE OF γ RADIATION. Gezalov, A. A.; Zhabrova, G. M. (Inst. of Chemical Physics, Moscow). Kinet. Kataliz. 8: 460–3(Mar.–Apr. 1967). (In Russian).

The chemisorption of H_2 and O_2 under the effects of γ radiation

was studied at temperatures of 20°C on samples of ZnO and a-Al_2O_3 characterized by approximately the same specific surface (14 to 13 m^2/g). It was found that at equal initial pressures the velocity of the chemisorption of O_2 exceeds that of the chemisorption of H_2. The radiation chemisorbed O_2 is bound to the surface of the solid investigated much more stably than that of H_2 from the viewpoint of the possibility of chemical interaction of the chemisorbed gases with the oxides and electron introduction. (tr-auth)

40888 DEGRADATION AND CROSS-LINKING OF POLY-(DIMETHYLSILOXANE) IN SOLUTION UNDER THE INFLUENCE OF ^{60}Co γ RAYS. Schnabel, Wolfram (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Makromol. Chem., 103: 103-8 (1967). (In German).

Radiochemical yields for main-chain scission and for cross-linking were determined for pure poly(dimethyl siloxane) as well as for poly(dimethy siloxane) irradiated in toluene solutions at various concentrations. For pure poly(dimethyl siloxane) the ratio of the specific densities of degradation and crosslinking p_θ/q_θ amounted to 0.015. In toluene solution, p_θ/q_θ steadily increased with decreasing concentration and approached infinity at a base mole fraction of the polymer of $x_P = 0.03$. At the critical concentration ($x_{Pcrit} = 0.15$), p_θ/q_θ was equal to 2. The 100 eV-yield of crosslinking decreased with decreasing polymer concentration and became zero in very dilute solutions. The 100 eV-yield for main-chain scission slightly increased with decreasing polymer concentration over a broad range of x_P; a more significant increase occurred at low concentrations. The results agreed with the previously developed theory of simultaneous degradation and crosslinking of polymers in solution under the influence of ionizing radiation. (BBB)

40889 CHEMICAL BEHAVIOUR OF TIN FISSION PRODUCTS. Brown, L. C.; Wahl, A. C. (Washington Univ., St. Louis). J. Inorg. Nucl. Chem., 29: 2133-45(Sept. 1967).

The oxidation states of 27-hr ^{121}Sn, 127-day ^{123}Sn, 9.7 day, ^{125}Sn, 2.1 hr ^{127}Sn, and 60-min ^{128}Sn formed from thermal neutron fission of ^{235}U were investigated in irradiated aqueous solutions of uranium and in aqueous solutions formed by dissolving irradiated uranium salts. In the irradiated solutions ^{121}Sn was formed predominantly (~⅔) in the +4 oxidation state, whereas the other isotopes were formed predominantly (~⅔) in the +2 state. The difference is attributed to different modes of formation, since ^{121}Sn is known to be formed ≥88 percent by beta decay and ^{125}Sn ≥70 percent independently. The similarity in the fractions of tin(II) for ^{123}Sn, ^{125}Sn, ^{127}Sn, and ^{128}Sn was taken as evidence that all of these isotopes have similar and large fractional independent yields. This deduction supports suggestions that the stability of the 50-proton structure enhances the primary formation of tin isotopes in fission. Similar, but smaller, differences between the fractions of tin(II) for ^{121}Sn and for the other isotopes were observed for solutions of irradiated uranium(IV) salts. Only tin(IV), however, was observed in solutions of irradiated uranium(VI) salts. Mechanisms are discussed which account qualitatively for the predominance of tin(IV) from beta decay and of tin(II) from fission in aqueous solutions. (auth) (UK)

40890 EFFECT OF SOME PHOTOSENSITIZERS ON THE RADIATION-CHEMICAL CROSSLINKING OF POLYETHYLENE. Kachan, O. O.; Chernyavs'kii, G. V.; Shrubovich, V. O. (Inst. of Chemistry of High-Molecular Compounds, Kiev). Dopov. Akad. Nauk Ukr. RSR, Ser. B, No. 7, 626-8(July 1967). (In Ukrainian).

Effects of the additives of chloroform, carbon tetrachloride, tetrachloroethylene, benzophenone, and phosphorus trichloride on the radiation-chemical crosslinking of polyethylene were studied. It was established that benzophenone, tetrachlorethylene, and phosphorus trichloride influence rather little the crosslinking of polyethylene under the action of γ rays from ^{60}Co. Carbon tetrachloride and chloroform were inhibitors of the process. (auth)

40891 AN ^{132}I GENERATOR FOR OIL-SOLUBLE SYSTEMS. Pinajian, J. J. (Oak Ridge National Lab., Tenn.). Int. J. Appl. Radiat. Isotop., 18: 665-6(Sept. 1967).

A generator system is described for the ion-exchange preparation of methyl ethyl ketone-bound 2.3-hr ^{132}I in a form suitable for use in oil-soluble materials. The parent activity for the preparation is fission product ^{132}Te, which was sorbed from HCl solution onto a Bio-Rad HZO-1 ion exchange column. The generator was milked with methyl ethyl ketone/HCl, a yield of ~70% of the available ^{132}I being obtained. (UK)

40892 PULSE RADIOLYSIS STUDIES OF THE REACTION OF H AND OH RADICALS AND HYDRATED ELECTRONS WITH PYRIDINE. Cercek, B.; Ebert, M. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Trans. Faraday Soc., 63: 1687-98(July 1967).

The transients produced by the reactions of pyridine with H and OH radicals (–H·C_5H_5N·H^+, –HO·C_5H_5N·H^+, –HO·C_5H_5N, –C_5H_5N·OH) and hydrated electrons (–C_5H_5N·H) were studied using the technique of pulse radiolysis. The absorption spectra of these species were obtained. Their formation and decay were studied under a variety of conditions, and rate constants for the following reactions obtained:

$$H + PyH^+ \rightarrow \cdot HPyH^+ \qquad (1.7 \pm 0.4) \times 10^8\ M^{-1}\ sec^{-1}$$

$$HO + PyH^+ \rightarrow HOPyH^+ \qquad (2.0 \pm 0.4) \times 10^7\ M^{-1}\ sec^{-1}$$

$$HO + Py \rightarrow \begin{matrix} \cdot HOPy \\ \cdot PyN-OH \end{matrix} \qquad (1.8 \pm 0.4) \times 10^9\ M^{-1}\ sec^{-1}$$

By computer analysis the second-order constants of $\cdot HPyH^+$ and $\cdot HOPyH^+$ radicals were found to be $3 \times 10^8\ M^{-1}\ sec^{-1}$, and those of ·HOPy, ·PyN–OH and ·PyN–H gave a value of $4 \times 10^8\ M^{-1}\ sec^{-1}$. (auth) (UK)

40893 PULSE RADIOLYSIS: ADDUCTS OF VINYL COMPOUNDS AND SIMPLE FREE RADICALS. Chambers, K. W.; Collinson, E.; Dainton, F. S.; Seddon, W. A.; Wilkinson, F. (Leeds Univ., Eng.). Trans. Faraday Soc., 63: 1699-1711(July 1967).

Pulse radiolysis of (a) aqueous de-aerated solutions of acrylamide, methacrylamide, N-t butyl acrylamide, acrylic acid, and acrylonitrile and (b) styrene and α-methyl styrene in deaerated cyclohexane, dioxane, tetrahydrofuran, and benzene resulted in intense transient absorption spectra. Those for system (a) were assigned to monomer radical anions, $m_1^-\cdot$, and the products of reaction of a radical with the monomer. Their decay was second order and values of the extinction coefficients and bimolecular rate constants were determined. Absolute rate constants (M^{-1} sec^{-1}) were obtained for the reaction of acrylamide with (a) hydrated electrons, $(2.1 \pm 0.4) \times 10^{10}$, (b) OH radicals, $(2.0 \pm 0.5) \times 10^9$, and for the reaction of the product of the reaction of the radical and monomer with oxygen and ferricyanide ion, $(1.9 \pm 0.3) \times 10^9$ and $(6.8 \pm 0.4) \times 10^8$, respectively. For system (b) the absorptions and decay kinetics observed were not completely understood. At least two distinct species were formed, one of which could be ascribed to a radical, but neither to a radical anion. (auth) (UK)

40894 CATIONIC POLYMERIZATIONS INDUCED BY RADIATIONS. Cordischi, D.; Mele, A. (CNEN, Rome). Chim. Ind. (Milan), 49: 151-62(1967). (In Italian).

This review (47 references) discusses some recent theories on distribution and stability of primary ionic species produced in the liquid phase by ionizing irradiation. On the basis of proposed models, a kinetic scheme is examined for radioinduced ionic polymerization. Examples are given of monomers that polymerize through ionic intermediates. How the presence of ionic species acceptors effects polymerization is discussed. Particular attention is given to polymerization of isobutylene, styrene, and α-methylstyrene. Effects of solvent, temperature, and other factors in cationic polymerization induced by ionizing radiation are also considered. (BBB)

40895 IDENTIFICATION OF THE NO_3 RADICAL IN $NaNO_3$ IRRADIATED AT 20 TO 77°K. Adde, Robert (CNRS, Saclay, France). Compt. Rend., Ser. C, 264: 1905-8(June 12, 1967). (In French).

Experimental studies on NO_3 radicals created by electron irradiation of $NaNO_3$ at low temperatures were completed. The production and annealing of NO_3 are described. Identification of the paramagnetic center A is discussed and attributed to the NO_3 radical. (J.S.R.)

40896 STUDY OF THE PRIMARY MECHANISMS OF THE RADIOLYSIS OF GASEOUS CO BY IRRADIATION WITH LOW-ENERGY ELECTRONS. Gitton, Bernard; Cottin, Maurice (Institut de Physique Nucleaire, Paris). Compt. Rend., Ser. C, 264: 1913-15(June 12, 1967). (In French).

A slow electron gun was developed. A study of the quantity of CO_2 formed by irradiation of CO with electrons of various energies made it possible to show the principal primary mechanism responsible for its formation. (tr-auth)

40897 USE OF A PLATINUM ALTERNATE-MOVEMENT MICROELECTRODE IN RADIATION CHEMISTRY. Busulini, Loris; Cescon, Paolo; De Antoni, Giulia (Centro di Chimica delle Radiazioni e dei Radioelementi, Bologna). Ann. Chim. (Rome), 57: 32-7(1967). (In Italian).

The possibility of using voltammetry in the study of radiochemical reactions was explored with the use of a Pt microelectrode replacing the dropping Hg electrode used by others. The radiolytic redox reaction of Fe(II) in Fricke's solution was chosen as

a model system. Results obtained with this electrode correlated very closely with data analyzed spectrophotometrically, and it is suggested that the electrode be employed for study of radiochemical reactions where the dropping Hg electrode is impractical. Illustrations of typical experimental data are given. (BBB)

40898 REACTIONS OF THE HYDRATED ELECTRON IN THE PHOTOCHEMISTRY OF AQUEOUS SULPHATE AND BISULPHATE IONS. **Barrett, Jack; Fox, M. F.; Mansell, A. L. (Hatfield Coll. of Tech., Eng.). J. Chem. Soc. A, No. 3, 483-6 (1967).**

Aqueous sulphate and bisulphate ions were irradiated at 1849 Å in the presence of methanol, ethanol, and 2-propanol. The gaseous product was hydrogen in every case. The quantum yields for sulphate ion and bisulphate ion photolysis were determined in terms of the hydrogen gas evolved as a result of the absorption of 1849 Å quanta by the respective ions. The use of acetone as an electron-scavenger indicated that the primary absorption process of sulphate ion involves charge-transfer. The effect of pH variation upon the photochemistry of the sulphate ion was investigated. (auth) (UK)

40899 PRODUCTS OF LOW MOLECULAR WEIGHT IN THE RADIOLYSIS OF AQUEOUS SOLUTIONS OF ETHYLENE. **Basson, R. A.; du Plessis, T. A. (Atomic Energy Board, Pretoria). Chem. Commun., No. 15, 775-6(1967).**

It has been found that a "polymer" is the major product in the radiolysis of dilute aqueous solutions of ethylene, together with small amounts of aldehydes and hydrogen peroxide. The "polymer" yield is directly proportional to the initial ethylene concentration and the product does not contain OH-groups. A thorough analysis of product distribution was made in an attempt to clarify the initial radiolysis stages. Gas chromatographic analysis, after irradiation of 1 to 4×10^{-3} M solutions to doses of 10^{18} to 2×10^{19} eV/ml. revealed the presence of butane, hexane, octane, decane, acetaldehyde, n-butyraldehyde, ethanol, butanol, and traces of hydrogen peroxide and propanol. The yields were strongly dependent on dose, tending to decrease with increasing dose, and on ethylene concentration. G-values are tabulated. The appreciable amounts of ethanol and butanol formed suggest that OH-radicals add to ethylene rather than abstract from it. The stoichiometry requires that equal amounts of ethanol and acetaldehyde, and also butanol and butyraldehyde, be formed. The fact that the aldehyde yields are lower than the alcohol yields is probably due to competition between ethylene and aldehyde, but not alcohol, for solvated electrons. Absolute rate constants support this suggestion. The high yields of butane and hexane suggest that chain termination occurs rapidly, as might be expected from polymerization kinetics. (UK)

40900 IRRADIATION AND THE SUBSEQUENT SOLID STATE THERMAL DECOMPOSITION OF SILVER NITRITE. **Schneller, J. W.; Flanagan, T. B. (Univ. of Vermont, Burlington). Nature (London), 215: 729-30(Aug. 12, 1967).**

The kinetics of thermal decomposition at 50°C were studied gravimetrically in vacuo following exposure to ^{60}Co gamma radiation at 1.5×10^4 R/hr, employing single crystals. In contrast to the behavior of solids in general, there was a marked reduction of rate of decomposition with dose. Irradiation was performed in vacuo, and there was no significant loss in weight during irradiation. If the irradiation was carried out in poor vacuum, or at atmospheric pressure, no effect on thermal decomposition was observed. This finding is thought to be of considerable importance, since it may apply to other reversible solid state decomposition reactions. It was found that the decomposition of both irradiated and unirradiated silver nitrite continued to completion if the evolved NO_2 was continually removed. The rate constants determined from the slope of the extensive linear region of the decomposition curves for runs at temperatures above 60°C fell below the extrapolated Arrhenius plot from data at lower temperatures. This fall-off was believed to result mainly from inhibition by gaseous products, and even with direct evacuation the gases were evolved too rapidly for complete removal. Similar results were observed on irradiation with x rays, except that in this case there appeared to be an inversion effect, probably due to inhibition by gaseous products. (UK)

40901 CHEMICAL EFFECTS OF THE $^{197m}Hg-^{197}Hg$ ISOMERIC TRANSITION IN DIMETHYLMERCURY, DIETHYLMERCURY, AND DIPHENYLMERCURY. **Heitz, Charles (Centre de Recherches Nucleaires, Strasbourg). Bull. Soc. Chim. France, No. 7, 2439-41(July 1967). (In French).**

Labeled ^{197m}Hg-, ^{197}Hg-, and ^{203}Hg- dimethylmercury, diethylmercury, and diphenylmercury were prepared by neutron irradiation of the pure compounds. Inorganic ^{197}Hg formed upon the de-excitation of ^{197m}Hg in acetone solutions of the labeled organomercurics was separated by adsorption on MnO_2. The ratio of the activities of ^{197}Hg and ^{203}Hg as measured by γ spectrometry in the initial product and in MnO_2 indicated that a chemical bond rupture occurs following the isomeric transition in the aliphatic compounds. No effect was observed for diphenylmercury which is attributed to the fast isotopic exchange between inorganic and bound mercury atoms. (auth)

40902 SZILARD-CHALMERS EFFECT ON DIMETHYLMERCURY, DIETHYLMERCURY, AND DIPHENYLMERCURY IN A PURE STATE AND IN A BENZENE SOLUTION. **Heitz, Charles (Centre de Recherches Nucleaires, Strasbourg). Bull. Soc. Chim. France, No. 7, 2442-6(July 1967). (In French).**

Dimethylmercury, diethylmercury, and diphenylmercury in the pure state and in benzene solution were irradiated in a thermal neutron flux. Retentions and enrichment factors were determined for ^{197m}Hg, ^{197}Hg, and ^{203}Hg; no isotopic effect was observed. The measured retentions were: 15% for dimethylmercury, 8% for diethylmercury, and 74% for diphenylmercury. The corresponding values in benzene solutions (0.1 M) were 13, 5, and 60%, respectively. The effects of the radiolytic decomposition of the target and of isotopic exchange reactions between metallic mercury and the parent compound were examined. (auth)

40903 RADIOINDUCED POLYMERIZATION OF THE THREE-DIMENSIONAL CYCLIC DICYCLOHEXYLPHOSPHINOBORANES. **Solomatina, A. I.; Chikishev, Yu. G.; Tsetlin, B. L.; Zamyatina, V. A.; Korshak, V. V. (Inst. of Elementary Organic Compounds, Moscow). Izv. Akad. Nauk SSSR, Neorg. Mater., 3: 381-3(Feb. 1967). (In Russian).**

Previously it was shown that the effects of ionizing radiation on dimethylphosphinoborane induced formation of polymer products of linear and polycyclic structures. An attempt was made at inducing radiation polymerization in three-dimensional dicyclohexylphosphinoborane (DCHPB). The three-dimensional dicyclohexylphosphine prepared, following crystallization from benzene, had a melting point of 255 to 256°C, molecular weight 710, and was easily dissolved in ether, benzene, and heptane but did not dissolve in methanol. Transformation of the monomer to a polymer for a specimen of DCHPB irradiated with 0.5×10^{10} RAD was 32.2%; for the specimen irradiated with 0.2×10^{8} RAD it was 20.7%; and for the specimen irradiated with 0.2×10^{9} RAD it was 21%. The data obtained indicated that radioinduced polymerization of the three-dimensional DCHPB is accompanied by broken rings and produced linear polymers and splitting cyclohexane molecules after further irradiation. The resulting tetracoordinated structure transformed into a less stable tricovalent one and the polymer obtained was easily oxidized by precipitation in air. (R.V.J.)

40904 BEHAVIOR OF COAL DURING IRRADIATION IN THE PRESENCE OF CHLORINE OR OXYGEN. **Muller, J.-C.; Le Bouffant, L. Chim. Ind. (Paris), 97: 1315-20(May 1967). (In French).**

Coal was irradiated with ^{60}Co at dose rates of 50 KRAD/hr and 1.75 MRAD/hr. Formation of CO_2 and H_2O as a function of temperature was followed. Oxidation and chlorination tests were carried out with and without γ-irradiation of the samples. The effect of oxygen was examined by studying the kinetics of oxidation and by determining such characteristics of the coal as elementary composition, heating capacity, smoke-producing capacity, and pyridine-extract composition. During the chlorination tests the kinetics of fixation of chlorine was studied and the elementary composition of pyridine extracts was determined. It was concluded that under the conditions of the experiments (0 to 200°C with doses up to 4 MRAD for chlorination, or 50 to 260°C with doses up to 82 MRAD for oxidation) that γ-irradiation had no detectable effects on these processes. (BBB)

40905 THE EFFECT OF X RADIATION UPON THE MOBILITY OF SILVER IODIDE SOLS. **Spivack, M. A. (Union Carbide Corp., Bound Brook, N. J.); Linford, H. B.; Odian, G.; Cropper, W. H. J. Colloid Interface Sci., 23: 358-66(Mar. 1967).**

Change in the electrophoretic mobility of negative AgI sols was studied as a function of the dose of 50-KV x rays. The change in mobility almost directly reflected the growth (and decay) of iodine in an iodide solution, the change possibly being caused by preferential absorption of iodine over iodide at the particle surface or by a change in the absorption characteristics of positive ions onto the double layer. When the colloid was saturated with He the mobility at first decreased and then increased to its original value, further irradiation again producing no additional changes. Contrary to previous findings, the results indicated that iodine is formed at low doses in dilute (less than 10^{-3}M) deaerated potassium iodide solutions; however, further irradiation reduced the iodine back to

iodide by radiation-produced hydrogen. Radioinduced H reduces the iodine in deaerated solutions and is therefore responsible for the mobility increase in He-saturated sols. (BBB)

40906 RADIATION CROSS-LINKING OF HYDROGENATED POLYETHYLENE. **Okada, T.; Mandelkern, L.; Glick, R. (Florida State Univ., Tallahassee). J. Amer. Chem. Soc., 89: 4790-2(Aug. 30, 1967).**

In order to determine the role of the vinyl group in the radioinduced cross-linking of linear polyethylene, the vinyl end group from a lower-molecular-weight sample was removed by hydrogenation. The crystallinity properties of hydrogenated and unhydrogenated samples were found to be identical. Results from the irradiation of hydrogenated and nonhydrogenated polyethylene in both the crystalline and completely molten states showed that for the nonhydrated sample the critical dosage required for gelation was about twice as great for the completely amorphous sample as for the highly crystalline one; but for the hydrogenated sample the highly crystalline sample required a slightly higher critical dose for gelation than did the amorphous polymer. It was concluded that the greater efficiency of cross-linking in the nonhydrogenated highly crystalling sample must result from reactions involving the vinyl end group. (D.H.M.)

40907 REACTION OF NITRIC OXIDE WITH TRIPHENYLMETHYLPEROXY RADICAL. **Janzen, Edward G.; Meyer, John L. Jr.; Ayers, Caroline L. (Univ. of Georgia, Athens). J. Phys. Chem., 71: 3108(Aug. 1967).**

The γ radiolysis of polycrystalline triphenylacetic acid produces triphenylmethyl radicals which react reversibly with oxygen to give triphenylmethylperoxy radicals. The reaction of NO with the triphenylmethylperoxy radical was investigated. Results point to the following reaction sequence: $(C_6H_5)_3COO\cdot + NO \rightarrow [(C_6H_5)_3 COONO] \rightarrow (C_6H_5)_3CO\cdot + NO_2$. (J.G.B.)

40908 THE EFFECT OF ADDITIVES ON THE RADIOLYSIS OF 1,2-DICHLOROETHANE. **Ueda, Hisashi (Tokyo Inst. of Tech.). J. Phys. Chem., 71: 3084-7(Aug. 1967).**

The effects of twenty-eight different additives on the gamma radiolysis of 1,2-dichloroethane were studied. Additive effects on G-values of the products, acetylene, ethylene, HCl, vinyl chloride, and cis- and trans-1,2-dichloroethylenes in pure dichloroethane are tabulated. (J.G.B.)

40909 INABILITY OF BROMINE TO SCAVENGE RADICALS IN γ-IRRADIATED SOLID HYDROCARBONS. **Iyer, R.M.; Willard, J.E. (Univ. of Wisconsin, Madison). Contract AT(11-1)-32. J. Phys. Chem., 71: 3070-1(Aug. 1967).**

An attempt was made to determine whether yields of free radicals produced by the radiolysis of solid hydrocarbons can be determined by using a halogen scavenger. Polycrystalline normal hexane containing 0.1 mole % $Br_2(^{82}Br)$ was γ irradiated at 77°K and dissolved in isopentane. In additional experiments conditions were varied slightly but all results indicated that organically bound bromine results from reaction with stable radiolysis products, and that free radicals are not scavenged by Br_2 either in the solid state or during the dissolving process. ESR studies confirmed these conclusions. (J.G.B.)

40910 THE BEHAVIOR OF F^- INTERSTITIALS DURING REDUCTION OF Dy^{3+} IONS IN CALCIUM FLUORIDE. **Fong, F. K.; Hiller, M.A. (North American Aviation Science Center, Thousand Oaks, Calif.). J. Phys. Chem., 71: 2854-60(Aug. 1967).**

Conversion of Dy^{3+} ions in CaF_2 host lattice to the divalent state by γ irradiation and by high-temperature treatment with Ca vapor was quantitatively investigated in an effort to elucidate the behavior of the F^- interstitials which charge-compensate the Dy^{3+} ions. It was found that the heat of complex formation of Dy^{3+} ions and F^- interstitials is -2.53 kcal/mole. Only the uncomplexed Dy^{3+} ions are reduced by γ irradiation. The migration of the F^- interstitials (to the crystal surface) during the Ca vapor treatment is the rate-determining step with an activation energy of 34.8 kcal/mole. The heat of reaction for the additive reduction (i.e., reduction by heating with Ca vapor) was found to be 68.5 kcal/mole, which explains why dysprosium ions (unlike Sm, Eu, or Tm) have not been observed to enter the CaF_2 lattice during crystal growth under reducing condition. (auth)

40911 KINETIC ANALYSIS OF HOT FLUORINE REACTIONS IN MODERATED METHANE–TETRAFLUOROMETHANE SYSTEMS. **Todd, John F. J.; Colebourne, Neville; Wolfgang, Richard (Yale Univ., New Haven). J. Phys. Chem., 71: 2875-84(Aug. 1967).**

The reactions of hot fluorine atoms with methane were studied. Energetic ^{18}F was produced by the $^{19}F(\gamma,n)$ process in mixtures of CF_4 and CH_4. The extent of hot reaction with CF_4 and CH_4 was varied by addition of neon as a moderator. Ethylene served to scavenge thermalized fluorine. To analyze the results, a new extension of the kinetic theory of hot reaction, applicable to reactive mixed systems, was developed. For systems in which the ratio of reactants to each other is kept constant, no further assumptions are required. This analysis yielded values of the reaction parameters for hot $F + CF_4$ in excellent agreement with those previously obtained in systems in which CF_4 was not mixed with another reagent. Reaction of hot ^{18}F with CH_4 yields both the single displacement product $CH_3{}^{18}F$ and the double displacement product $CH_2{}^{18}F$. The total yield of these products and the ratio of single displacement to double displacement are considerably higher than the analogous quantities in the $F + CF_4$ system. In terms of product yield, the $F + CH_4$ reaction thus seems to be intermediate between $F + CF_4$ and $T + CH_4$. (auth)

40912 REACTIONS OF ELECTRONS AND HYDROGEN ATOMS WITH OXYGEN AND METHYL BROMIDE IN γ-IRRADIATED WATER VAPOR. **Johnson, G. R. A.; Simic, M. (Univ., Newcastle-upon-Tyne, Eng.). J. Phys. Chem., 71: 2775-80(Aug. 1967).**

Oxygen and methyl bromide reacted efficiently with the electrons and hydrogen atoms produced by irradiation of water vapor–propane mixtures. In the $D_2O + C_3H_8 + O_2$ system, the dependence of the HD and H_2 yields on the ratio O_2/C_3H_8 is consistent with a simple competition of O_2 and C_3H_8 for the D and H atoms produced radiolytically from D_2O and C_3H_8, respectively. The rate-constant ratio $[M]k_{(D+O_2+M)}/k_{(D+C_3H_8)} = 105 \pm 10$ (M = D_2O, 140°). The same value, within experimental error, was obtained for the corresponding ratio for H atoms. The D atom yield, extrapolated to zero concentrations of O_2 and C_3H_8 ($G(D)^0_w = 5.5 \pm 0.5$), is consistent with efficient electron capture by O_2, which prevents the formation of D atoms by hydronium ion neutralization. In the system $D_2O + C_3H_8 + CH_3Br$, the dependence of the HD and CH_3D yields on the ratio CH_3Br/C_3H_8 was studied. It was concluded that the reaction, $D + CH_3Br \rightarrow CH_3D + Br$, competes with the dehydrogenation of C_3H_8 by D atoms and the $G(D)^0_w = 4.6 \pm 0.4$ and $k_{(D+CH_3Br)}/k_{(D+C_3H_8)} = 2.9$. It is suggested that electron capture by CH_3Br gives CH_3Br^- and that neutralization involves reaction of this negative ion with D_3O^+ to give CH_3D as a product. The formation of CH_3D by this process is eliminated by SF_6 and by O_2, which are more efficient electron scavengers than CH_3Br. (auth)

40913 RADIATION SYNTHESIS OF ION-EXCHANGE MATERIALS. **Egorov, E. V. Usp. Khim., 36: 1270-86(July 1967). (In Russian).**

Radiation synthesis of copolymers can be carried out by: direct grafting of a monomer on a polymer by irradiation; irradiating a polymer in vacuum with subsequent contact with a monomer; irradiating a polymer in air while heating in a monomer medium; cross-linking two irradiated polymers in the solid state, in a melt or in a solution; irradiating an emulsion of two polymers, or a polymer and a monomer; and grafting with localized neutron irradiation. Details of these methods of synthesis, analysis, and testing are reviewed. Integral doses from 0.1 to 10×10^6 rads are required at dose rates of 4 to 100 rads/sec. The homogeneity and strength of the copolymers are important properties. Ion-exchange resins and fibers can also be synthesized by radiation synthesis. (132 references). (TTT)

40914 RADIATION RESISTANCE OF KU-4 CATIONITE. **Kiseleva, E. D.; Chmutov, K. V.; Klientovskaya, M. M.; Li, V. P. (Inst. of Physical Chemistry, Moscow). Zh. Fiz. Khim., 41: 1590-6(July 1967). (In Russian).**

The effects of ionizing radiation of a beam of accelerated electrons on the cation exchange resin KU-4, a copolymer of acenaphthylene with divinylbenzene, were investigated as a function of radiation dose. During irradiation of the resin at doses from 0.1 to 1.2×10^{23} eV/g, a decrease of the volume and mass and a change of the swelling of KU-4 were observed. The radiation stability depended on the degree of bonding of the sorbent. The most stable samples were KU-4 containing 20 to 30% divinylbenzene. The equilibrium coefficients $K_H^{Cs^+}$ and $K_H^{Pm^{3+}}$ on irradiated and unirradiated KU-4 were determined with different additions of divinylbenzene. Equilibrium coefficients increased with an increase in bonding and decreased in irradiated samples. The internal diffusion kinetics of the Pm^{3+} ion exchange in nitric acid solution in irradiated and nonirradiated samples of porous structure were investigated. (tr-auth)

40915 KINETIC STUDY OF RADIATION VAPOR-PHASE GRAFT-COPOLYMERIZATION ON MINERAL POWDERS. **Morozov, Yu. L.; Plotnikova, L. I.; Rafikov, S. R.; Tsetlin, B. L. (Inst. of Elemental-Organic Compounds, Moscow). Vysokomol. Soedin., 9: 1627-34(Aug. 1967). (In Russian).**

Kinetics of vinyl copolymerization on mineral surfaces under continuous x-irradiation of the solid–vapor systems was studied using methyl methacrylate and styrene polymerized on magnesium oxide and silica. Rate dependence on the monomer sorption on the

powder, its vapor pressure, temperature, dose rate, and quantity of grafted polymers were studied. The process took place in the kinetic region up to relatively thick layers of the grafted polymer. The decisive role belongs to monomer sorption on the irradiated surface. (auth)

40916 RADIATION GRAFT-COPOLYMERIZATION OF GLYCIDYL METHACRYLATE TO POLYETHYLENE. Kabanov, V. Ya.; Kazimirova, N. M.; Spitsyn, Vikt. I. (Inst. of Physical Chemistry, Moscow). Vysokomol. Soedin., 9: 1758-62(Aug. 1967). (In Russian).

Graft copolymers of polyethylene with polyglycidyl methacrylate containing epoxy groups were prepared by γ-polymerization. IR spectra were studied. The kinetics of radiation grafting at different dose rates and temperature was studied. At a certain critical temperature the reaction rate decreased sharply. ESR spectra of glycidyl methacrylate and poly(glycidyl methacrylate) showed their shape and radiation yield to be close to poly(methyl methacrylate). The vapor-phase grafting resulted in low yield possibly due to increased temperature of the samples. (auth)

40917 RADIOLYSIS OF METHANE IN A WIDE-RANGE RADIOLYSIS SOURCE OF A MASS SPECTROMETER. I. INDIVIDUAL AND TOTAL CROSS SECTIONS FOR THE PRODUCTION OF POSITIVE IONS, NEGATIVE IONS, AND FREE RADICALS BY ELECTRONS. Melton, Charles E.; Rudolph, P. S. (Oak Ridge National Lab., Tenn.). J. Chem. Phys., 47: 1771-4(Sept. 1, 1967).

The abundances of, and the total and individual cross sections for, primary products (positive ions, neutral species, and negative ions) resulting from elementary reactions induced by the absorption of energy by CH_4 from ionizing radiation (100-eV electrons) were measured. This was accomplished with the dual electron beam section of wide-range radiolysis source. The results showed that positive ions and free radicals were produced in nearly equal abundances, 45% and 55%, respectively. On the other hand, negative ions were less abundant by about four orders of magnitude. The The total cross section for positive ionization (σ_i) by 100-eV electrons was 3.8×10^{-16} cm^2 and that for the formation of neutral species (σ_N) was 4.7×10^{-16} cm^2. To independently test the reliability of the dual electron-beam ion source, the total and individual cross sections for ionization of Ar by 100-eV electrons were measured for comparison with published values. The value for the total cross section (σ_i) of 3.24×10^{-16} cm^2 was in satisfactory agreement with those reported by other workers, whose values range from (2.8 to 3.6) $\times 10^{-16}$ cm^2. (auth)

40918 ELECTROSTATIC MODEL FOR THE THEORY OF IONIC RECOMBINATION RATE. Mozumder, A.; Magee, J. L. (Univ. of Notre Dame, Ind.). J. Chem. Phys., 47: 1859-60 (Sept. 1, 1967). (COO-38-547).

A theory of ionic recombination rate for application to cases of high ionization density such as may be produced by the absorption of a relatively large dose of radiation in a medium of low dielectric constant is discussed. The dependence of ion densities and potential on radial distance was investigated. Rate constants obtained in the two cases studied were lower than the corresponding Debye values by factors of 1.6 and 18.6. (D.H.M.)

40919 GAMMA RADIOLYSIS OF MASKED AMINO ACIDS. Badiello, Roberto; Breccia, Alberto (Univ., Bologna. CNR, Bologna). Ric. Sci., 37: 332-6(Apr. 1967).

Dried preparations of amino acids, chemically substituted in the terminal $-NH_2$ and $-COOH$ groups, were gamma irradiated. EPR and IR spectroscopy and radiochromatographic analyses were carried out. The production of free radicals ($G = 10^{-6}$ to 10^{-5}) in the substituted compounds was particularly low, but that in the unsubstituted amino acids was quite high ($G = 0.5$ to 5). The spectroscopic and radiochemical analyses confirmed the finding that the whole molecule of the amino acid is more stable to gamma irradiation when its terminal groups are protected. (auth)

40920 PREPARATIVE ISOTOPIC ENRICHMENT OF RUBIDIUM BY CONTINUOUS COUNTERCURRENT ELECTROLYSIS. VIII. REPORT ON COUNTERCURRENT ELECTROLYSIS. Wagener, K. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Ber. Bunsenges. Phys. Chem., 71: 627-9(July 1967). (In German).

The output of a small laboratory plant of 1-kW energy consumption was determined. By continuous countercurrent electrolysis of an aqueous solution of Rb acetate a rate of 40 mg Rb per day could be obtained from each end of the column. The total yield after 75 days was 3 g Rb with a ^{87}Rb content of 30.8%, and 3 g with 24.5%, respectively. Without Rb output, the column gave an enrichment of ^{87}Rb up to 40.8%, while in the waste the content was 17.2%. (auth)

40921 METASTABLE IONS IN THE MASS SPECTRA OF PROPANE AND DEUTERATED PROPANES. Ottinger, Ch. (Univ., Freiburg, i. B.). J. Chem. Phys., 47: 1452-7(Aug. 15, 1967).

The metastable transitions of the three-carbon ions of propane, 2,2-dideuteropropare, and 1,1,1,2,3,3,3-heptadeuteropropane were investigated. Twenty-one transitions involving loss of one or two H or D atoms were detected. A very strong isotope effect, which effectively suppresses D elimination for ions in which H elimination is a possible competitive process, was also established, confirming earlier results for the methane system. Only secondary propyl ions were formed via a metastable decay, and little or no hydrogen-atom migration in the parent ion occurred prior to dissociation. In addition, elimination of the isotopic species in secondary reactions was far from statistical, suggesting that scrambling is also incomplete for these ions. (auth)

40922 INDUSTRIAL PERSPECTIVES OF RADIATION CHEMISTRY. Dobo, Janos. Magy. Kem. Lapja, 22: 293-300(June 1967). (In Hungarian).

Chemonuclear reactors, when constructed, will furnish radiation energy at very low cost and in high quantities. For the near future, however, sources independent of reactor operation (cobalt sources and accelerators) are of interest for Hungary. Since the radiation from such sources is comparatively expensive, only processes of high effectivity can be envisaged for industrial application. As to the choice between isotopes and accelerators, the type of process, economics, and running experiences have to be considered. (auth)

40923 PREPARATION OF PERMSELECTIVE MEMBRANES BY MEANS OF A RADIOINDUCED GRAFTING. I. CATIONSELECTIVE. Munari, S.; Vigo, F.; Tealdo, G.; Rossi, C. (Univ., Genoa. Centro Nazionale Chimica Macromolecole, Genoa). J. Appl. Polym. Sci., 11: 1563-70(Aug. 1967).

Permselective cationic membranes were prepared by a radioinduced grafting method of styrene onto PTFE, and a preirradiation technique was used. Some attempts were made to characterize the membranes. They show mechanical properties similar to the PTFE matrix, and good electrochemical behavior, i.e., good permselectivity, which, nevertheless, decreased with decreasing solution concentration. Such behavior was related to a larger swelling in diluted solutions. Swelling properties in aqueous solutions of KCl and some organic solvents are also reported. (auth)

40924 γ-RADIOLYSIS OF THE ETHANOL-BENZENE SYSTEM AT -196°C IN THE PRESENCE OF ELECTRON SCAVENGERS. Kroh, Jerzy; Mayer, Jozef (Technical Univ., Lodz, Poland). Chem. Phys. Lett., 1: 191-4(July 1967).

The γ-radiolysis of the $C_2H_5OH-C_6H_6$ system was investigated at -196°C, both in the presence of, and without, H_2SO_4. In neutral solutions, C_6H_6 acted chiefly as an electron scavenger. In solutions 1N in H_2SO_4, C_6H_6 reacted preferably with H atoms formed in the reaction of $CH_3CH_2OH_2^+$ ions with electrons. The rate constant ratio $[K(e^- + C_2H_5OH)]/[K(e^- + C_6H_6)] = 5.2 \times 10^{-5}$ and the yield of scavengable electrons $G_{(e^-)} = 0.85$. (auth)

40925 ON THE PARAMAGNETIC CENTERS FORMED IN IRRADIATED POLYCRYSTALLINE $SeO_4(NH_4)_2$. Constantinescu, M.; Constantinescu, O.; Pascaru, I. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 12: 110-11(1967).

The ESR spectra of γ irradiated polycrystalline $SeO_4(NH_4)_2$ were studied at 77 and 300°K. Results indicate the formation of SeO_4^-, SeO_3^-, and SeO_2^-. Formation of SeO_3^- was the least affected by temperature change, SeO_4^- the most affected. ESR spectra seem to indicate the existence of another, as yet unidentified, radical. (J.G.B.)

40926 SOLID-STATE RADIATION POLYMERIZATION OF TRISELENANE TO POLENOMETHYLENE. Carazzolo, Gianalvise; Mammi, Mario (Societa Montecatini-Edison, Varese, Italy. CNR, Padua). J. Polym. Sci., Part C, No. 16, 1521-7(1967).

From International Symposium on Macromolecular Chemistry, Prague, Aug. 30-Sept. 4, 1965. See CONF-650801-(Pt.3).

Triselenane, the cyclic trimer of selenoformaldehyde $(CH_2Se)_3$, subjected to gamma irradiation, was partially converted into crystalline polyselenomethylene $(CH_2Se)_n$. The solid-state polymerization was proved to take place in two directions, parallel to the two [hh0] and [hh̄0] diagonal axes in the ab plane of the trimer orthorhombic unit cell. The polymer crystal lattice is orthorhombic with a = 5.37 A, b = 9.03 A, c = 4.27 A, and space group $P2_12_12_1$; the polymer chains are helicoidal with their axes parallel to c. (auth)

40927 GAMMA IRRADIATION OF DILUTE AQUEOUS ALKYL BENZENE SULFONATE SOLUTIONS. Fleischman, Marvin; Price, Robert H. (Univ. of Cincinnati). Environ. Sci. Technol., 1: 573-7(July 1967).

The effects of dissolved oxygen level, pH, initial ABS concentration, iron concentration, and total dose on gamma-induced degradation and oxidation of ABS were experimentally investigated, primarily by the methylene blue and chemical oxygen demand methods. At an absorbed dose of 54,000 RADS 98% of the ABS was destroyed. G values for degradation, G(–ABS), increased with decreasing pH. An optimum ratio of ferrous ion concentration to ABS concentration was found at which G(–ABS) increased 97% and G for oxidation, $G(-O_2$ eq.), increased 52% over the values in the absence of iron at the same pH. Both G values were substantially higher in solutions containing oxygen than in deoxygenated solution. G(–ABS) ranged from 0.510 to 2.46, while $G(-O_2$ eq.) ranged from 0 to 67. (auth)

40928 THEORY OF RADIATION CHEMISTRY. VIII. IONIZATION OF NONPOLAR LIQUIDS BY RADIATION IN THE ABSENCE OF EXTERNAL ELECTRIC FIELD. Mozumder, A.; Magee, J. L. (Univ. of Notre Dame, Ind.). J. Chem. Phys., 47: 939-45(Aug. 1, 1967). (COO-38-503).

A theory of separated ion pairs in the x and γ irradiation of nonpolar liquids is presented. In this theory consideration is made of the mechanisms involved in the thermalization of electrons, and it is shown that a very significant portion of the prethermalization electron range occurs while the electron is in the subvibrational energy region (~0.4 eV to thermal energy). The temperature dependence of the yield of separated charges arises in a perfectly natural manner. "Thermalization lengths" turn out to be 80 to 90 Å. Good agreement with experimental observations is obtained with reasonable values of the three adjustable parameters. The theory is also applied to the special case of ^{37}Ar, where most of the effect is due to 2.4-keV conversion electrons. Calculated results are in reasonable agreement with experiment in this case. A small temperature effect is predicted. (auth)

40929 UP TO DATE DATA ON RADIATION CHEMISTRY OF WATER AND AQUEOUS SOLUTIONS. Pikaev, A. K. Vestn. Akad. Nauk SSSR, No. 6, 54-60(June 1967). (In Russian).

Available data on the radiation chemistry of water and aqueous solutions are reviewed. A typical scheme of an installation for a pulse radiolysis with short-life particle recording and an example of an optical absorption spectrum of a hydrated electron in irradiated water at 25°C are given. The principal properties of free radical products of water radiolysis are tabulated. (R.V.J.)

40930 REACTIVE SPECIES PRODUCED IN STYRENE AND POLYETHYLENE BY IONIZING RADIATION AND HYDROGEN ATOMS. Phalangas, Charalambos John. College Park, Md., Univ. of Maryland, 1966. 161p.

Thesis.

The radioinduced graft polymerization of styrene to polyethylene at low temperatures, radioinduced ionic grafts on polyethylene, and the effects of thermal hydrogen atoms on polyethylene were studied. During the investigation of the first problem the effects of dose rate and temperature on the polymerization rate and molecular weight were studied. The results demonstrate that kinetic theories derived for the radioinduced polymerization in the liquid state do not apply in the solid state, the theories advanced for the radioinduced solid state polymerization do not fit the styrene data, any attempt to deduce a mechanism for the radioinduced polymerization of solid styrene from average kinetic data alone is unlikely to be fruitful, and the explanations of the behavior of the system attempted so far by different authors and the mechanism of polymerization ascribed to it are, at present, incomplete and uncertain. The second problem was attacked by testing the ability of isobutene and α-methylstyrene to form radioinduced ionic graft on polyethylene fluff. No detectable amount of graft was formed during the irradiation of the isobutene–polyethylene fluff system. In the case of the α-methylstyrene-polyethylene fluff system, a small amount of weight gain was obtained. In the investigation of the third problem an apparatus was designed and conditions established for the production of hydrogen atoms in the ground state. Their effects on polyethylene films and expanded polyethylene were studied. A finely divided polyethylene fluff was developed. The development of the fluff made possible the observation by EPR spectroscopy of the free radical intermediates produced by hydrogen atom bombardment on polyethylene and their comparison with those created by ionizing radiation. An isotopic exchange was obtained when deuterium gas was allowed to react at room temperature with polyethylene fluff previously bombarded with hydrogen atoms. The results from the bombardment of polyethylene films and foam indicate that the treatment can increase the molecular weight of polyethylene by cross-linking reactions. They also suggest that a process in which only hydrogen atoms produced by a microwave discharge are used for the production of cross-linked polyethylene films cannot be an economic competitor to ionizing radiation. The EPR patterns of the hydrogen atom bombarded polyethylene fluff revealed that one of the free radicals produced is the alkyl radical also produced by radiation. There are indications that allyl radicals are also formed in a somewhat lower yield relative to the alkyls than that obtained by radiation. A broad absorption which decays by a second order mechanism with a velocity constant 2.6×10^{-20} g(spins)$^{-1}$sec^{-1} was also observed. (Disser. Abstr.)

40931 STABILIZATION OF SULPHUR TRIOXIDE BY RADIATION. (to Tennessee Corp.). British Patent 1,078,835. Aug. 9, 1967. Priority date Sept. 17, 1964, United States.

A method for stabilizing SO_3 consists of irradiating the substantially anhydrous liquid SO_3 with ionizing radiation for a period of 30 min to 24 hr at a dose rate of 1.4×10^6 RAD/hr or greater. (B.L.M.)

40932 IMPROVEMENTS IN AND RELATING TO THE CARRYING OUT OF RADIATION-INITIATED CHEMICAL REACTIONS. (to Farbwerke Hoechst Aktiengesellschaft). British Patent 1,081,394. Aug. 31, 1967. Priority date Sept. 6, 1963, Germany.

A process and an apparatus are described for carrying out radio-induced chemical reactions using γ radiation from a power reactor. The vessel containing the chemical reactants is placed outside the nuclear reactor vessel between the wall of the reactor vessel and the biological shield. The chemical reaction vessel at least partially replaces the thermal shield, which consists of a container filled with an aqueous solution of B or Cd salts or a mixture of these. (B.L.M.)

40933 METHOD FOR MAKING ALCOHOLS BY IONIZING RADIATION. (to Mobil Oil Corp.). British Patent 1,076,802. July 26, 1967. Priority date Oct. 2, 1963, United States.

A process for producing alcohols comprises irradiating with high-energy ionizing radiation a flowing mixture of reactants in the liquid or vapor phase. The reactant mixture consists of a starting alcohol having fewer C atoms than the product alcohol and an olefin. The dose rate is 1 to 40 MRAD/hr and the radiation is applied to the reactants for a period of time from 10 sec to 10 min. If the reactants are in the vapor phase, the temperature must be maintained sufficiently high to ensure complete vaporization. (B.L.M.)

40934 RADIATION TREATMENT OF AN INDUSTRIAL WASTE. Mytelka, A. I. (AeroChem Research Labs., Inc., Princeton, N. J.); Manganelli, R. M. 30p. (CONF-670523-2). DTIE.

From 22nd Annual Purdue Industrial Waste Conference, Lafayette, Ind.

Gamma-induced changes in an azo dyestuff waste and the effects of these changes on the biological degradation of the waste were studied. As the radiation dose increased, organic compounds became more amenable to biological oxidation. (P.C.S.)

Radiochemistry

40935 (CONF-661044) ARBEITSTAGUNG ANGEWANDTE RADIOAKTIVITAET, LEIPZIG, 11. BIS 14. OKTOBER 1966. (Symposium on Applied Radioactivity (Radiation), Leipzig, October 11–14, 1966. (Deutsche Akademie der Wissenschaftne zu Berlin (East Germany). Institut fuer Angewandte Radioaktivitaet). 154p. (In German). Dep.

The three invited papers at the Symposium on Applied Radioactivity are presented in full. These discuss radionuclides in science, the application of tracer isotopes for methodical studies in the chemical and metallurgical industries, and the chemistry of hot atoms. Abstracts of papers presented to the various sections are compiled. The topics discussed are radiochemical analysis, physical analysis methods with radioisotopes, tracer studies in chemical kinetics, metrology, labeling, and special applications of radioisotopes. (J.S.R.)

40936 (UCRL-70493) THE CONFIGURATION AND DESIGN PHILOSOPHY OF THE LIVERMORE NEUTRON SHIELDED CHEMISTRY CELLS. Coops, M. S.; Hanson, C. L. (California Univ., Livermore. Lawrence Radiation Lab.). July 11, 1967. Contract W-7405-eng-48. 18p. (CONF-671102-18). Dep. CFSTI.

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill.

Four neutron-shielded radiochemical research cells capable of safely handling one gram quantities of ^{252}Cf are presently being constructed at the Livermore site. These cells are equipped with total-containment, replaceable cell liners (boxes) and are constructed so that highly alpha-contaminated operations are conducted through the front face of the shielding and non-contaminated oper-

ations are carried on through the rear face. Each of the four cells are located above the legs of an X-shaped transfer tunnel system, which allows transfers between the cells and a large transport cask. Manipulations are performed in the main cells by use of short-stroke, extended reach master-slave manipulators. Viewing is afforded by large neutron–gamma shielding windows located in each operating face. Cell shielding walls are constructed from four-foot-thick steel tanks filled with crushed magnetic ore and borated water. (auth)

40937 (ORNL-tr-1750) STANDARDIZATION OF RADIONUCLIDES BASED ON DETERMINATIONS OF MASS. Klumpar, J. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Isotopenpraxis, 3: 32-3(1967). 4p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

Calculation of the activity of radioisotopes from experimentally determined mass is discussed. By use of this method, the decay constant can be determined directly from the rate of decrease of activity. The advantage of the method proposed lies in the fact that in all cases it involves only a relative measurement, in which the type of radiation plays no part. (M.C.G.)

40938 TO THE THEORY OF RADIATION CHEMISTRY. III. SEMIEMPIRICAL CALCULATION OF BREAKDOWN CURVES UNDER THE ASSUMPTION OF LIMITED NUMBER OF EFFECTIVE OSCILLATORS. Prasil, Z. (Inst. of Nuclear Research, Rez, Czechoslovakia). Collect. Czech. Chem. Commun., 32: 2906-16(Aug. 1967).

A method is described for determining the empirical parameters with which the classical approximation gives results corresponding to mass-spectrometrically measured breakdown curves of molecular ions. The determined values of parameters are discussed and used for the calculation of breakdown curves of neutral molecules and molecular ions in the time 10^{-10} sec. These curves can be used for the calculation of primary radiochemical yields in the gas phase. The fluctuation of energy among fragments is included in the calculation. (auth)

40939 CHEMICAL VALENCE STUDIES IN NUCLEAR DECAY. THE $^{127m}Te \rightarrow {}^{127}Te$ REACTION IN $^{127m}Te(OH)_6$ CRYSTALS. Andersen, T.; Johansen, L.; Olesen, K. (Univ. of Aarhus, Denmark). Trans. Faraday Soc., 63: 1730-6(July 1967).

The chemical effects following isomeric transition of ^{127m}Te in $^{127m}Te(OH)_6$ crystals were investigated. The influence of added crystal defects on the initial chemical distribution and on thermal annealing reactions is negligible. A model based on the hypothesis of the supply of charge carriers from the IT-formed fragments to the radioactive recoil atoms was shown to account quantitatively for the data obtained for thermal annealing of the $^{127}Te(IV)$ forming fragments. (auth)

40940 EFFECT OF CRYSTAL SIZES ON THE THERMAL ANNEALING OF INTERSTITIALS PRODUCED BY SZILARD–CHALMERS RECOIL. Gorla, P. R.; Lazzarini, E. (CESNEF, Milan). Energ. Nucl. (Milan), 14: 537-40(Sept. 1967).

The effect of crystal sizes on thermal annealing of interstitial atoms formed by Szilard–Chalmers recoil was studied in $[Co(NH_3)_6](NO_3)_3$, trans-$[Coen_2(NO_2)_2]NO_3$, and $(NH_4)_2CrO_4$. The crystal sizes ranged from 2 to 3 mm and 2 to 10 μ. It was found that the crystal sizes influence the thermal annealing curves; the effect consists in a variation of the annealing rates as well as in a variation of the plateau values, which were lower for crystals having smaller sizes. These results are discussed in terms of competitive processes occurring during the thermal annealing: annealing rate of Co or Cr interstitial atoms and decomposition rate of crystals at the boundary, which enhances the ligand cage diffusion in crystals having smaller sizes. Thus the number of sites suitable for the restoration of the original compounds was reduced for crystals having smaller sizes. (auth)

40941 RANGES OF HEAVY PARTICLES. II. RANGES OF ^{224}Ra RECOILS IN GASES. Wiechmann, W.; Biersack, J. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Nukleonik, 9: 399-400(May 1967). (In German).

In the α decay of ^{228}Th recoil atoms of ^{224}Ra with an energy of 96 keV are produced. The integral range distributions of these recoil atoms were experimentally measured in various gases. (Ar, Ne, He, O_2, N_2, H_2, CH_4, and $C_2H_2 + 3H_2$.) The recoil ranges and the range scattering were tabulated for the various gases and compared with theoretical values. The comparison showed a satisfactory agreement up to the range of H_2 for which the shielding radius used does not represent a good approximation. (J.S.R.)

40942 REACTIONS OF THE CARBONIUM IONS FROM THE DECAY OF PROPANE-1,2-t_2 IN GASEOUS AND LIQUID PROPANE. Cacace, Fulvio; Caroselli, Marcello; Guarino, Angelo (CNR, Rome. Univ., Rome). J. Amer. Chem. Soc., 89: 4584-8 (Aug. 30, 1967).

The chemical fate of a tritiated propane molecule following the decay of the radioactive atom was studied with a tracer technique involving the use of propane-1,2-t_2. The isotopically pure compound was allowed to decay in the presence of a large excess of inactive propane, both in the gas phase at 1 atm and in the liquid phase at −130°C. The analysis of the labeled decay products was carried out by radio gas chromatography. The results obtained were compared with the low-pressure, decay-induced fragmentation pattern of propane-1-t and propane-2-t. The results were consistent with the view that the dissociation process, $C_3H_7^+ = C_3H_5^+ + H_2$, of the excited daughter ions observed at 10^{-5} torr is largely prevented in the gas phase at 1 atm by collisional deactivation processes, as suggested by the low yields of molecular hydrogen and propylene. The stabilized $C_3H_6T^+$ ions reacted with the inactive propane to give monotritiated propane and unlabeled propyl ions, indicating a thermoneutral hydride ion transfer process. Those $C_3H_6T^+$ ions (20%) that receive from the nuclear decay a larger excitation energy fragmented into smaller ions and gave tritiated products other than propane. The nature and the yields of the labeled products observed were in good agreement with those expected, if the low-pressure fragmentation pattern and the ion-molecule reactions that are known to occur within the system are to be taken into account. In the liquid phase, the only major product observed was propylene, along with a smaller amount of molecular hydrogen. The product distribution suggests that, when the decay takes place in liquid propane, most of the daughter $C_3H_6T^+$ ions are stabilized. Even in those cases when the nuclear transition leaves the organic ion in a highly excited state, its dissociation is limited to the first step, i.e., to the process $C_3H_6T^+ = C_3H_4T^+ + H_2$. The $C_3H_4T^+$ ion, reacting with the inactive propane, eventually gave rise to tritiated propylene. (auth)

40943 THE ISOMERIC EFFECT IN SZILARD-CHALMERS RECOIL OF ^{60m}Co AND ^{60g}Co IN SEVEN SALTS OF TRIS-(PROPYLENEDIAMINE) Co(III). Lazzarini, E.; Fantola-Lazzarini, A. L. (Centro Studi Nucleari, Milan). Energ. Nucl. (Milan), 14: 472-4(Aug. 1967).

It was previously demonstrated that ^{60m}Co and ^{60g}Co have different behavior in their Szilard–Chalmers recoils. This isomeric effect is measured by means of the retention ratio of the ^{60m}Co and the ^{60g}Co. The value of the effect varied with the chemical constitution of the target compound. In Co(III) complexes the effect was chiefly dependent on the constitution of the first coordination sphere of Co(III), while the rest of the crystal structure plays a secondary role. This was confirmed by the results; it was found that the seven examined salts of tris-(propylenediamine) Co(III) complex ion have, in a first approximation, the same value of isomeric effect. (auth)

Separation Processes

Refer also to abstracts 40767, 40772, 41396, and 41403.

40944 (BLG-422) SEPARATION OF ^{226}Ra, ^{227}Ac, AND ^{228}Th BY ION EXCHANGE. Huys, D.; Baetsle, L. H. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)). May 1967. 8p. Dep.

Relying on the particular properties of synthetic organic ion exchange resins in concentrated $HClO_4$ a separation method for radium–actinium–thorium has been developed. Radium is eluted in 12 M $HClO_4$, actinium is washed by 3 M HNO_3, and finally thorium is eluted by 3 M H_2SO_4. Since organic ion exchangers are used the method is only suited for analytical separations. A new method making use of titanium phosphate as ion exchanger (ABEDEM–Ti–A) has been worked out. Thorium is absorbed on titanium phosphate in 4M HNO_3 and radium can be trapped in 2M HNO_3. Actinium is not fixed in these media and emerges radiochemically pure at the end of the second column. Separations with milligram quantities of ^{226}Ra, ^{227}Ac, and ^{228}Th have proven to be successful. Full-scale operations at the multicurie level are possible with this new method. (auth)

40945 (CONF-670542) CONFERENCE ON NUCLEAR POWER FUEL REPROCESSING: TECHNOLOGY AND ECONOMICS HELD AT AUGUSTA, GEORGIA, MAY 11–12, 1967. (Savannah River Operations Office (AEC), Aiken, S. C. Southern Interstate Nuclear Board, Atlanta, Ga.). 224p. Dep. CFSTI.

Fifteen papers presented at the conference are included. Separate abstracts were prepared for 10 of the papers. (M.C.G.)

For abstracts of individual papers see: 40880 and 40946–40954.

40946 (CONF-670542–, Paper 1) NUCLEAR FUEL REPROCESSING: IMPORTANCE TO THE UTILITIES. Lee, William S. (Duke Power Co., Charlotte, N. C.). 16p.

Nuclear fuel reprocessing is of economic importance to utilities,

and they also have a strong interest in technology and safety associated with reprocessing. It is suggested that nuclear power will grow at a rate faster than reflected in currently published forecasts. As a consequence, plans for additional reprocessing capacity must be accelerated if the needs of utilities are to be met. Need for a reprocessing plant in the Southern Interstate Nuclear Board (SINB) area is discussed. (auth)

40947 (CONF-670542–, Paper 2) GENERAL ELECTRIC COMMERCIAL REPROCESSING PLANS. Reinker, Paul H. (General Electric Co., Santa Clara, Calif. Nuclear Energy Div.). 12p.

Studies aimed at developing a reprocessing approach specifically designed to handle power reactor fuels are reviewed. Site selection studies resulted in the choice of a midwest location, south of the Dresden Nuclear Power Station near Morris, Illinois. The Aquafluor is to be used. Feed preparation is by mechanical disassembly. The fuel material is leached from the cladding in a vibrating trough conveyor using nitric acid circulated from a reservoir. A single cycle of solvent extraction is used for initial separation of the valuable materials from the highly radioactive fission product waste. The aqueous solution is then concentrated and fed to a semicontinuous anion-exchange contactor, which removes plutonium. Neptunium is removed in a second anion-exchange contactor. The nitrate solution remaining contains the uranium and some fission products. This solution is concentrated to the hexahydrate state and then fed into a fluidized-bed calcium to produce anhydrous UO_3. The resulting UO_3 is fluorinated in a fluidized bed. The product UF_6 is purified and packaged for shipment. (M.C.G.)

40948 ((CONF-670542–, Paper 3) ALLIED CHEMICAL CORPORATION NUCLEAR POWER FUEL REPROCESSING FACILITIES AND PLANS. Osborn, K. R. (Allied Chemical Corp., Morristown, N. J. Nuclear Fuels Dept.). 12p.

Potentialities of a fluoride volatility process were reviewed. Research and related economic evaluation of the application of high-reactivity selective fluorinating agents as a means of solving the plutonium separation problem of the volatility process were carried out. Economic and technical problems faced by a nuclear fuel reprocessor are examined. (M.C.G.)

40949 (CONF-670542–, Paper 4) HISTORY OF SPENT FUEL REPROCESSING. Tremmel, Ernest B.; Egli, Richard L. (Division of Industrial Participation (AEC), Washington, D. C.). 17p.

The AEC's program to develop a chemical reprocessing capability in private industry is reviewed. (M.C.G.)

40950 (CONF-670542–, Paper 5) CURRENT AEC PROGRAM. Shaw, Milton (Division of Reactor Development and Technology (AEC), Washington, D. C.). 29p.

Utility acceptance of reactors, advanced reactor programs, efficient use of fuel resources, development of the liquid-metal-cooled fast breeder reactor (LMFBR), importance of the fuel cycle and waste management, comparison of light-water reactor (LWR) and LMFBR fuel characteristics, transition cycles, LWR fuel cycle economics, fluoride volatility processes, LWR waste management, LMFBR fuel cycle economics, LMFBR reprocessing development program, and waste management are discussed. (M.C.G.)

40951 (CONF-670542–, Paper 6) DESCRIPTION OF ATOMIC ENERGY COMMISSION CHEMICAL PROCESSING FACILITIES. Hobbs, Isaac A. (Savannah River Operations Office (AEC), Aiken, S. C.). 15p.

AEC fuel processing facilities are in operation at Richland, Washington, the National Reactor Testing Station, Idaho Falls, and at the Savannah River Plant. Generally, all three sites employ the Purex process or modified versions of it for continuous separation and decontamination of uranium and plutonium from irradiated fuel elements. Design and operation of the Savannah River Plant are discussed. Waste disposal methods are described. (M.C.G.)

40952 (CONF-670542–, Paper 7) CURRENT CONSIDERATIONS OF COMMERCIAL REPROCESSING. Runion, T. C. (Nuclear Fuel Services, Inc., West Valley, N. Y.). 23p.

The AEC's post-1967 reprocessing policies, the prices for reprocessing of spent nuclear fuel, international safeguards, and plans for the future in reprocessing and associated activities are discussed. (M.C.G.)

40953 (CONF-670542–, Paper 8) DESCRIPTION OF NFS' FACILITIES FOR THE REPROCESSING OF NUCLEAR POWER FUEL. Braun, C. R. (Nuclear Fuel Services, Inc., West Valley, N. Y.). 13p.

The flowsheet for the process used by NFS to recover uranium and plutonium from spent nuclear fuels is shown. Shielded casks containing the spent fuel are unloaded underwater. The fuel is transferred from the pool to a mechanical processing cell and sheared. The fuel values and fission products are dissolved in nitric acid. TBP is used as a solvent to separate the majority of the fission products from the contained uranium and plutonium values. The uranium and plutonium are then separated by solvent extraction. The uranium product stream is concentrated by evaporation and subjected to a final decontamination with silica gel, resulting in a uranyl nitrate solution product. The plutonium product stream is subjected to an ion-exchange treatment to effect both concentration and further decontamination yielding plutonium nitrate solutions. (M.C.G.)

40954 (CONF-670542–, Paper 9) NUCLEAR FUEL REPROCESSING EXPERIENCE AND COSTS. Behnke, Wallace B. Jr. (Commonwealth Edison Co., Chicago, Ill.). 19p.

Commercial reprocessing of fuel discharged from the Dresden-1 light-water power reactor is discussed. Operation of Dresden-1 is reviewed. Transportation of spent fuel is described. Surveillance of the fuel reprocessing operations, including analytical results, is discussed. (M.C.G.)

40955 (EUR–3608.f) ELAN O: EXTRACTION DU CAESIUM DES PRODUITS DE FISSION SUR COLONNE D'ECHANGEUR MIXTE: PILOTE INACTIF. (ELAN O: Extraction of Cesium From Fission Products on Mixed Exchanger Column: Inactive Pilot Plant). Courouble, J. M.; Pesneau, A.; Prevotel, M. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). July 6, 1967. 92p. (In French). Dep.

Laboratory results obtained with the phosphotungstate mixed exchanger led to consideration being given to the construction of a pilot plant capable of extracting cesium from actual fission-product solutions. The scale of 1000 Ci of cesium-137 extracted per operation was chosen in order to be compatible with the general shielding and effluent-discharge facilities available at the Saclay Center. Before constructing this pilot, however, it was necessary to carry out various operations on an apparatus of the same size but operating in an inactive medium. (auth)

40956 (HW–78880) NUCLEAR SAFETY REVIEW: NEW PLUTONIUM RECLAMATION FACILITY. Z PLANT: 200 WEST AREA (CAC–880). Brown, C. L. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). June 28, 1963. Contract AT(45-1)-1830. 46p. Dep. CFSTI.

The nuclear safety of the Plutonium Reclamation Facility was reviewed. Individual processing vessels, the "process cell" taking into account the neutron interaction between vessels, the plutonium processing areas outside the process cell, and the piping and ventilation systems were evaluated. The GAM I–TEMPEST–HFN code combination was used to obtain effective multiplication constants for the plutonium solution systems. All vessels and vessel arrangements were found to be critically safe for plutonium concentrations up to at least 450 g/l. The vessels were not critically safe for large (over 2-kg) additions of plutonium metal. The 6-in. IO vessels were geometrically favorable only if neutron reflection is limited to nominal. The floor of the process cell was critically safe for any postulated leakage of plutonium solution. Four ways were postulated by which criticality might occur if nuclear safety control was lost. (M.C.G.)

40957 (IS–1600, Paper 2) CHEMICAL ENGINEERING DIVISION. Spedding, F. H.; Burnet, G.; Burkhart, L. E.; Chiotti, P.; Shuck, F. O.; Smutz, M.; Stevenson, F. D. (Ames Lab., Iowa). 16p.

Developments are reported for studies on: separation of rare earths using D2EHPA as solvent; TBP vs D2EHPA as a solvent for separating rare earths; monazite rare earth nitrates–HNO_3–H_2O–TBP extraction; wetting characteristics of liquid metals; liquid metal corrosion; estimation of thermodynamic data from phase diagrams; liquid metal diffusion; vapor–liquid equilibria in liquid metal systems; kinetics of niobium oxychloride chlorination; reduction of $NbCl_5$ by niobium metal using a gas chromatograph; separation of Nb and Ta pentachlorides; extraction from single drops; fused salt–molten metal extraction; spin-echo NMR techniques in diffusion; process simulation on digital computers using analog methods; and single crystal preparation. (P.C.H.)

40958 (K–L–1780(Pt.20)) ORGDP FUEL REPROCESSING STUDIES. Progress Report for Period Ending April 30, 1967. Smiley, S. H. (Oak Ridge Gaseous Diffusion Plant, Tenn.). July 21, 1967. Contract W-7405-eng-26. 33p. Dep. CFSTI.

Decladding mode tests were initiated in the semiworks reactor using HCl. Additional pellet oxidation experiments were carried out with emphasis on elutriative transfer of U_3O_8 from the bed. Two reactor shakedown fluorination runs were performed using elemental fluorine. Filters were performance tested in volatility process corrosive atmospheres. A sample splitter for use in reactor bed sampling was evaluated. ANL reactor bed material was

fluorinated to provide feed for ORNL waste processing studies. (M.C.G.)

40959 (MLM-1399) MOUND LABORATORY PROGRESS REPORT FOR CHEMISTRY: OCTOBER-DECEMBER 1966. (Mound Lab., Miamisburg, Ohio). Dec. 30, 1966. Contract AT-33-1-GEN-53. 51p. Dep. CFSTI.

Developments are reported for studies on: determination of coincidence corrections; alpha-beta branching ratio of ^{227}Ac; residue adsorption; half-life of ^{147}Pm; transitions in ^{227}Ac populated by alpha decay of ^{231}Pa; hydrolysis of U(IV) in nitrate media; thermal dehydration of uranyl nitrates; preparation of large crystals of Pu compounds; preparation of high-density PuO_2; precipitation of plutonium oxalate in presence of fluoride ion; preparation of microspheres by the sol-gel process; Pu-acetylacetone systems; valence instability of ^{238}Pu; ^{234}U recovery; ^{229}Th recovery; concentration of U from ^{233}U separations; gamma energy analysis with a Ge(Li) detector; x-ray diffraction of plutonyl nitrates; x-ray fluorescence analysis; and stilbene crystal, fast neutron spectrometer. (P.C.H.)

40960 (MLM-1412) LOADING OF SULFONIC ACID TYPE CATION EXCHANGE RESINS WITH TETRAVALENT AND HEXAVALENT ^{238}Pu. Silver, G. L.; Buzzelli, O. R. (Mound Lab., Miamisburg, Ohio). May 2, 1966. Contract AT(33-1)-Gen-53. 11p. Dep. CFSTI.

The equilibrium of ^{238}Pu with sulfonic acid-type cation-exchange resins is described. A three-dimensional model useful in characterizing the loading of these resins with ^{238}Pu is presented. The loading of the resins with hexavalent ^{238}Pu is followed by loading of the resins with internally generated tetravalent plutonium. (auth)

40961 (ORNL-P-3252) THE HANDLING OF KILOGRAM QUANTITIES OF ^{233}U BY DIRECT AND REMOTE METHODS AT THE OAK RIDGE NATIONAL LABORATORY CENTRAL DISPENSING FACILITY. Parrott, J. R.; Brooksbank, R. E. (Oak Ridge National Lab., Tenn.). [1967]. Contract W-7405-eng-26. 21p. (CONF-671102-16). Dep. CFSTI.

For presentation at 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill.

The ^{233}U facility at Oak Ridge National Laboratory serves as a national center for receiving, storing, purifying, and dispensing ^{233}U. Kilogram quantities (solid or solution) can be safely stored, retrieved for processing, and purified to remove daughter products, chemical impurities, and fission products. The handling techniques, both direct and remote, are described in detail; special processing equipment and controls for the prevention of a nuclear excursion are also described. (auth)

40962 (TID-23991(Vol.1)) SAFEGUARDS PROCEDURES MANUAL FOR THE NFS REPROCESSING PLANT. VOLUME I. DEVELOPMENT. Wischow, R. P.; Clark, J. R.; Roll, I. B. (Nuclear Fuel Services, Inc., West Valley, N. Y.). Feb. 8, 1967. Contract AT(38-1)-452. 77p. Dep. CFSTI.

A system comprised of inspection procedures was developed to allow the NFS Reprocessing Plant to be safeguarded during the processing of safeguarded fuel. These inspection procedures were explicitly written for the NFS plant, incorporating the applicable, previously developed inspection systems and control methods. Application of these procedures to other reprocessing plants of the same general type should be relatively straightforward. Three types of inspection programs were developed from the procedures; manpower requirements varied from 14 men for a surveillance-only effort, 10 men for the Yankee exercise and 18 men for a program that would approach complete verification of safeguarding fuel to the accountability limits. Estimated annual labor costs for resident inspection are $367,600, $263,600, and $483,600 for the 14, 10, and 18 man programs, respectively. At an annual processing rate of 225 tons uranium per year (1,125 kg plutonium per year) the incremental labor costs for these programs are $0.33, $0.23, and $0.43 per gram of contained plutonium. Costs for the Yankee safeguarding during the processing of fuel is a fraction of the estimated annual costs and is dependent on the proper requirements developed by the inspection agency. Safeguarding during processing of Yankee safeguarded fuel can be done with a ten-man team. An intensive on-the-site training is recognized as a prerequisite for this program and a group of observers should be assigned to observe and evaluate the exercise. (auth)

40963 (TID-23991(Vol.2)) SAFEGUARDS PROCEDURES MANUAL FOR THE NFS REPROCESSING PLANT. VOLUME II. PLANT DESCRIPTION. Wischow, R. P.; Clark, J. R. (Nuclear Fuel Services, Inc., West Valley, N. Y.). Dec. 15, 1966. Contract AT(38-1)-452. 249p. Dep. CFSTI.

Background information on the Nuclear Fuel Services (NFS) Reprocessing Facility is presented. The facility, safeguarded fuel, Purex process, fuel receiving and storage, mechanical processing, chemical processing, product loadout and shipping, waste disposal, accountability, health and safety, maintenance, and security are discussed. (M.C.G.)

40964 (TID-23991(Vol.3)) SAFEGUARDS PROCEDURES MANUAL FOR THE NFS REPROCESSING PLANT. VOLUME III. PROCEDURES. Wischow, R. P.; Clark, J. R.; Roll, I. B. (Nuclear Fuel Services, Inc., West Valley, N. Y.). Jan. 6, 1967. Contract AT(38-1)-452. 272p. Dep. CFSTI.

Detailed procedures suggested for use by an inspection team to implement a program to detect diversion of nuclear materials from the NFS fuel reprocessing plant are presented. These procedures were designed, insofar as possible, to be independent of one another and to be followed in detail by an on-site Inspectorate. Three separate Safeguards programs are suggested: a surveillance program, a ten-man program, and an approach to accountability limits. The procedures are described in sequence according to the processing of the fuel. (M.C.G.)

40965 PREDICTION OF ^{99m}Tc YIELD FROM ^{99}Mo GENERATORS. Hidalgo, John U.; Wright, Robert M.; Wooten, Mary Margaret. J. Nucl. Med., 8: 426-9(June 1967).

In the laboratory operation of the $^{99}Mo/^{99m}Tc$ generators, it is customary to assay the eluant for specific activity and total activity of ^{99m}Tc pertechnetate. A simple method is described that enables the operator to compute the available ^{99m}Tc at any time following elution. (auth)

40966 NITROGEN ISOTOPE EQUILIBRATION ON MOLYBDENUM. Gasser, R. P. H.; Hale, A.; Marsay, C. J. (Oxford Univ.). Trans. Faraday Soc., 63: 1789-93(July 1967).

The efficiency of a molybdenum wire as a catalyst for the nitrogen isotope equilibration reaction, $^{28}N_2 + {}^{30}N_2 = 2{}^{29}N_2$, was studied for filament temperatures between 800 and 1900°K and nitrogen pressures between 1.8×10^{-7} and 1.8×10^{-6} torr. The efficiency was essentially independent of pressure and passed through a maximum of about 1.4% at 1300°K. The reaction took place only when the filament temperature was high enough to cause a measurable desorption of gas from a saturated filament. (auth) (UK)

40967 VARIABLES AFFECTING ION EXCHANGE FOR INTERACTINIDE SEPARATIONS. Aly, H. F.; Latimer, R. M. (Univ. of California, Berkeley). J. Inorg. Nucl. Chem. 29: 2041-5(Aug. 1967).

The actinide elements are usually separated by ion exchange. Cation resin and 2-methyllactic acid were studied with respect to the following variables: flow rate, resin-particle diameter, temperature, and column dimensions. Although separation factors remained constant except for temperature, resolution improved with low flow rates, small resin-particle diameters, high temperatures, and long resin beds. Techniques for obtaining small uniform resin particles and for loading samples on resin beds are discussed. (auth) (UK)

40968 THE EXTRACTION CHROMATOGRAPHY OF CALIFORNIUM AND EINSTEINIUM WITH A HIGH MOLECULAR WEIGHT QUATERNARY AMMONIUM NITRATE. Horwitz, E. P.; Sauro, L. J.; Bloomquist, C. A. A. (Argonne National Lab., Ill.). J. Inorg. Nucl. Chem. 29: 2033-40(Aug. 1967).

The separation of californium and einsteinium by extraction chromatography was studied using a high-molecular-weight quaternary ammonium nitrate (Aliquat-336 nitrate) absorbed on hydrophobic diatomaceous earth. $LiNO_3$ solution was used as the elutriant. Column performance as a function of mesh size, flow rate, and temperature was studied by measuring the number of theoretical plates obtained for Cf(III) elutions on columns with a capacity of 0.15 m-mole of NO_3^-/ml of bed. The distribution coefficient for Cf(III) was measured as a function of nitrate normality for the quaternary ammonium nitrate extractant absorbed on diatomaceous earth and dissolved in xylene. The extraction chromatography method was applied to the separation of both tracer and microgramme quantities of Cf and Es. The separation factor [Es(III)/Cf(III)] was 1.46. Columns were operated at room temperature and relatively fast flow rates (~1 ml/cm^2 per min). (auth) (UK)

40969 PYROCHEMICAL PROCESSING OF BREEDER REACTOR FUELS. Knoch, Werner (Technische Hochschule, Brunswick). Chem.-Ing.-Tech., 39: 1030-5(Sept. 1967). (In German).

In connection with the development of fast breeder reactors, high-temperature processes for the periodic reprocessing of irradiated fuels are becoming more important. In addition to a short, comprehensive survey of the processes that were developed to a technical scale, a new concept, that of the so-called salt-transport process, is discussed. Substances were extracted selectively from a metallic melt into a salt melt and, after trans-

port through the latter, were re-extracted into a second metallic melt, which was spatially separated from the first metal melt. The salt melt functioned as solvent, oxidant, and transport medium. (auth)

40970 INVESTIGATIONS OF THE DECOMPOSITION OF MONAZITE BY HEATING WITH CARBON AND QUARTZ. Holzapfel, H.; Richter, H.; Schaefer, D.; Werner, G. (Karl-Marx-Univ., Leipzig, Ger.). J. Prakt. Chem., 34: 83-90(1966). (In German).

The reaction of monazite with C and quartz was studied at temperatures between 1400 and 1700°C. In addition to elementary P, silicates of the lanthanides and of Th are formed and may be extracted with HCl. A process is suggested by these observations in which an arc oven is employed. The state of the sinter is stabilized by excess C in the briquet and by removal of the quartz portion. At 1500°C partial sintering and melting occurs as P is given off. Further heating to 1700°C with molten quartz produces the silicate. Excess coal dust is removed in a CO stream, and the silicate melt collects above the liquid ferrophosphor. Both are drained and the granulated silicate is finally crushed and extracted. (BBB)

40971 SEPARATION OF p-DEUTERIUM FROM NORMAL DEUTERIUM BY MEANS OF ADSORPTION. Zimoglyad, B. N.; Blagoi, Yu. P.; Zhun, G. G. (Physical-Technical Inst., Kharkov). Zh. Fiz. Khim., 41: 1519-21(June 1967). (In Russian).

On the basis of selective absorption of p-deuterium on aluminum oxide chromatographs, a method was developed for the production, in a one-stage process, of deuterium containing up to 90% and more of the p-modification. As a result of the analysis of the factors affecting the separation of the modifications during fractional desorption, the possibility of improving the method was indicated. (tr-auth)

40972 REGULARITIES IN THE THERMODYNAMICS OF ISOTOPIC EXCHANGE. III. FACTORS IN A SERIES OF RELATED COMPOUNDS. Knyazev, D. A.; Bantysh, A. N.; Ivlev, A. A. Zh. Fiz. Khim., 41: 1441-6(June 1967). (In Russian).

Some regularities, connecting the β factors of elements in a series of multiatomic related compounds, were reported. From the thermodynamic viewpoint, the most profitable for isotopic separation by the method of chemical exchange, there are systems, including compounds in which the given element coordinates as peripheral atoms one of the metalloids of the second period and shows its maximum valence (or maximum possible coordination number) and compounds in which the given element is connected with the metalloids of the following periods of the periodic table and shows a maximum valence possible in the presence of the first compounds (maximum possible coordination number). Chemical exchange methods under similar conditions are the most promising for separation of isotopes of polyvalent elements. (tr-auth)

40973 KINETICS OF URANYL NITRATE EXTRACTION BY TRIBUTYL PHOSPHATE SOLUTIONS IN BENZENE. Nikolaev, A. V.; Yurtov, A. I. (Inst. of Inorganic Chemistry, Novosibirsk, USSR). Zh. Fiz. Khim., 41: 1329-35(June 1967). (In Russian).

Using as an example the extracting system $UO_2(NO_3)_2$–TBP, it was shown that the stationary-state method, proposed by Frank–Kamenetskii for diffusion kinetics of heterogeneous systems, is also applicable for steady-flow or closed systems. The reactions between uranyl nitrate and TBP solutions in benzene proceed by five orders, during which the orders with respect to the separate components are respectively UO_2^{2+} – 1, NO_3^- – 2, and TBP – 2. The activation energy is 2.9 kcal/mol. The mechanism for the interaction between uranyl nitrate and TBP was confirmed. (tr-auth)

40974 THE INFLUENCE OF THE SALT COMPOSITION OF KU-2 CATION RESIN ON THE RATE OF INTERDIFFUSION SORPTION PROCESSES IN RARE EARTH ELEMENTS. Matorina, N. N.; Shepetyuk, L. V.; Chmutov, K. V. (Inst. of Physical Chemistry, Moscow). Zh. Fiz. Khim., 41: 1802-4(July 1967). (In Russian).

The effect of the ion composition of resins on the sorption kinetics of rare earth elements by the cationite KU-2 from diethylenetriaminepentaacetate (DTPA) solutions was investigated under conditions excluding processes of complex formation in the cationite. The values obtained for the coefficients of internal diffusion of Eu^{3+} in the presence and absence of DTPA $(1.4 \pm 0.3) \times 10^{-7}$ cm^2/sec and $(2.2 \pm 0.5) \times 10^{-7}$ cm^2/sec showed that the change of the ionic composition of the resin as a result of the sorption of DTPA by the cationite does not significantly affect the rate of interdiffusion. The reasons for the significant decrease of interdiffusion during sorption of the rare earth elements in the presence of complexing agents are discussed. (tr-auth)

40975 SEPARATION OF NITROGEN ISOTOPE BY CHEMICAL EXCHANGE OF AMMONIA IN ALCOHOL WITH AMMONIA. Kuznetsov, A. I.; Panchenkov, G. M. (Moscow State Univ.). Zh. Fiz. Khim., 41: 2062-5(Aug. 1967). (In Russian).

Separation of nitrogen isotopes by chemical exchange with thermal phase transformation was studied using two-phase systems formed by ammonia and complex ammonia compounds with n-propyl alcohol. Optimum parameters were found for nitrogen isotopic separation by the method. (R.V.J.)

40976 APPLICATION OF THIN-LAYER CHROMATOGRAPHY TO THE SEPARATION OF INORGANIC IONS. NOTE III. SEPARATION OF A MIXTURE OF ELEMENTS FROM NUCLEAR FUEL IRRADIATED IN THE SACLAY EL-3 REACTOR. Bottura, Giorgio; Breccia, Alberto (Univ., Bologna, CNR, Bologna). Ric. Sci., 37: 295-9(Apr. 1967). (In Italian).

Thin-layer chromatography with activated silica gel was applied, using the mono- and bidimensional technique, to the fast separation of a mixture of Ce, Cs, Ru, and U nuclides in microquantities, from nuclear fuel irradiated in the EL-3 reactor of Saclay (France), together with the inactive elements Al, Fe, Ni, Na, and Mg. (auth)

40977 THE SEPARATION OF ^{210}Po(RaF) BY COPRECIPITATION WITH TANNIC ACID. Zsoldos, Tibor; Csovari, Sophia; Banyai, Jozsef. Magy. Kem. Foly., 73: 307-10(July 1967). (In Hungarian).

A method for separation of ^{210}Po from aqueous solutions is reported. In addition to Te-carrier coprecipitation, ^{210}Po was also precipitated in the form Te(Po) galloylgallate. After dissolution of the precipitate the ^{210}Po was separated from the solution by spontaneous deposition on Ni disks. The dependence of ^{210}Po deposits on deposition time and a correction factor on account of volume losses during deposition were determined. The yield amounted to 80 ± 5%. (tr-auth)

40978 PRELIMINARY STUDIES OF STATIC LEACHING OF THE U LIGNITES OF THE REGION OF CALAF. Garcia Corral, M. A.; Nuno, E. Energ. Nucl. (Madrid), 11: 102-7(Mar.-Apr. 1967). (In Spanish).

The static leaching of U lignite containing U_3O_8 of the order of 0.165% was analyzed from an economic and industrial viewpoint. The test methods were outlined and leaching with dilute solutions, concentrated solutions, and with oxidants was studied. The lignites were leached with a dissolution of U of the mean order of 84.2%. There was no appreciable dissolution of U with water without the addition of sulfuric acid. The presence of small quantities of oxidizing reagents in the solution caused an increase in the degree of extraction. The most favorable results were obtained with concentrations between 50 and 100 g H_2SO_4/l. (J.S.R.)

40979 CHROMATOGRAPHIC SEPARATION OF CARRIER-FREE ^{90}Sr AND ^{90}Y ON PAPER IMPREGNATED WITH STANNIC PHOSPHATE. Chang, Chu-chun (Northwestern Univ., Hsian, China). Hua Hsueh Hsueh Pao, 31: 547-9(1965). (In Chinese).

The paper strip (30 cm × 25 cm) is treated successively with 30% $SnCl_4$ solution, 13% NaH_2PO_4 solution in 0.5M–NaOH, and 3M–HCl, then finally washed with H_2O until the pH of the washings is 6. The sample solution (1 drop) containing ≈20 mCi of the carrier-free nuclides per ml is applied to the prepared paper, and the chromatogram developed at 20°C for 90 min with 0.1M to 2M NH_4NO_3, HNO_3, or HCl by the ascending technique. Good separations were achieved, but the R_F values for Sr were increased by increasing the concentration of the developer. Development with 1M NH_4NO_3 containing a small amount of methanol, ethanol, or acetone gave lower R_F values for Sr. (Analytical Abstr.)

40980 THE SEPARATION OF ISOTOPES IN DUAL-TEMPERATURE SYSTEMS WITH OPEN CIRCUITS. Mercea, V.; Grecu, E.; Olariu, A. (Inst. of Atomic Physics, Cluj). Rev. Roum. Phys., 12: 20-42(1967).

Dual-temperature systems with open circuits are discussed, and the conditions under which separation takes place were established. It appears that between the isotopic concentrations in the liquid and gas, at the middle and at the ends of the systems of columns, there exist linear relations. A separation triangle is defined. A correlation between the classical dual-temperature system with closed circuits and the systems with open circuits was made: in the classical system a maximum separation was obtained. A possibility for the graphical determination of the experimental values for the parameters α_i and k_i of the system is indicated. (auth)

40981 EUROCHEMIC: THE WORLD'S FIRST INTERNATIONALLY OWNED NUCLEAR FUEL REPROCESSING PLANT. OECD (Org. Econ. Coop. Develop.), Observ., No. 24, 24-5(Oct. 1966).

An illustrated description is given of the plant built at Mol in Belgium by Eurochemic. As an international joint undertaking of the OECD European Nuclear Energy Agency, this Company was

established for operating a chemical reprocessing plant to treat used fuels from reactors in participating countries and for carrying out industrial experimentation on such fuels. The plant is able to accept for reprocessing both natural or enriched U fuels in oxide or metallic form contained in a large variety of claddings of different shapes and dimensions. Although a multipurpose plant with pilot character, it is built on an industrial scale and was designed to allow easy and rapid expansion of capacity in step with increasing demand for reprocessing. The plant is intended to operate under commercial conditions. (BBB)

40982 FUNDAMENTAL STUDIES ON THE ION EXCHANGE SEPARATION OF ISOTOPES. IX. SEPARATION FACTOR OF URANIUM ISOTOPES. 3. Gonda, Kozo (Atomic Fuel Corp., Tokyo); Kawashima, Nobuyoshi; Kakihana, Hidetake. Nippon Genshiryoku Gakkaishi, 9: 376-81(July 1967). (In Japanese).

Breakthrough experiments were carried out to study ion-exchange separation of uranium isotopes. Four kinds of solutions containing natural uranium (mole fraction of ^{235}U $0.720_0 \times 10^{-2}$, (1) 0.05M TnOA/benzene solution saturated with U(IV)-chloro complex, (2) mixture of 0.05M TnOA/benzene solution saturated with U(IV)-chloro complex and 0.05M TnOA/benzene solution saturated with U(VI)-chloro complex, (3) 0.05M TBP/benzene solution with U(IV)-chloro complex, and (4) mixture of 0.05M TBP/benzene solution saturated with U(IV)-chloro complex and 0.05M TBP/benzene solution saturated with U(VI)-chloro complex, were passed through 100 cm long, 1.3 cm diameter anion exchange resin columns until the composition of the effluents became equal to that of the feed solutions. Near the front of the breakthrough of solution (4) above, the ^{235}U was found enriched to $0.732_4 \times 10^{-2}$ (enrichment factor 1.017), while for solution (2), ^{235}U was depleted to $0.710_7 \times 10^{-2}$ (enrichment factor 0.987). From the total amounts of ^{235}U enriched or depleted by these breakthrough experiments, single-process ion-exchange separation factors of uranium isotopes were estimated to be 1.000000 for solution (1), 1.00033 for solution (2), 0.99989 for solution (3), and 0.99988 for solution (4). Based on these data, the apparent equilibrium coefficients of the electron exchange reaction, $^{236}U(VI) + {}^{238}U(IV) \rightleftharpoons {}^{238}U(VI) + {}^{235}U(IV)$ were estimated to be 1.0010 and 1.0013 for TnOA/benzene and TBP/benzene systems, respectively. These values are smaller than the value of 1.0020 previously obtained for 8M hydrochloric acid. The apparent equilibrium coefficient of the electron exchange reaction in the anion exchange resin (Dowex 21K) was estimated to be 1.0010 to 1.0013. (auth)

40983 NEW TENDENCIES IN THE PREPARATION OF NUCLEAR FUEL. I. Baran, Vaclav (Inst. of Nuclear Research, Czechoslovakian Academy of Sciences, Rez). Jad. Energ., 13: 246-53(July 1967). (In Czech).

Problems in the wet way preparation of nuclear fuel are considered. Based on the material available, recent production experience as well as results of laboratory investigations are described. Attention is paid, first of all, to the ways of transformation of hexavalent uranium to tetravalent, namely, electroreduction, catalytic reduction by means of hydrogen or other chemical reductants, photoreduction, and combined methods. (auth)

40984 ION-EXCHANGE REACTIONS OF RADIOACTIVE IONS WITH SOILS AND EFFECTS OF ORGANIC COMPOUNDS. Kown, Bong Taick. Urbana, Ill., Univ. of Illinois, 1966. 160p. Thesis.

The ion-exchange reactions of radionuclides with soil minerals and the effects of various water-soluble organic compounds on the reactions were investigated. Various theories concerned with ion-exchange reactions were examined for their practicability in predicting the equilibrium distribution of radionuclides in a soil environment. The effects of various water-soluble organic compounds on the ion-exchange reactions of a radionuclide with soil minerals (Mississippi montmorillonite and Fithian Illite) were studied using organic compounds selected from groups known to be present in the natural environment and in certain wastes discharged from nuclear facilities. The organic compounds include those that interact with metal ions (both the radionuclides and the competing counter ions) and others that may interact with soil particle surfaces. Experimental results indicated that the mass-action law can be applied to describe ion-exchange equilibria in most systems except those involving hydrogen ions. Difficulties of applying theories for a system involving hydrogen ions resulted from the fact that the ion-exchange sites of the clay minerals consisted of different types of sites. General rules of selectivity hold for most pairs of counter ions regardless of the types of exchange sites; however, due to different types of reactions involved, the selectivity of hydrogen changed as the ions occupied the exchange sites. An effort was made to examine the theories concerned with ion exchange and metal chelate chemistry as they apply to predicting the distribution of radionuclides in a system containing soils; chelating agents on the distribution of strontium ions in equilibrium with soil ion-exchange media followed the general rules regarding the stability of metal chelates and the selectivity of soil exchange media. The effects depended on the nature and the concentration of the competing counter ion present. In the presence of counter ions (Ca^{2+} and Zn^{2+}) that formed more stable chelates than Sr^{2+}, the presence of chelating agents increased the exchange adsorption of Sr^{2+} ions on soil-exchange media; on the other hand, when the counter ions (Mg^{2+} and Na^{+}) that formed less stable chelates were present, chelating agents increased the concentration of Sr^{2+} ions in the solution phase. The effects of organic adsorption were examined in terms of changes in the soil ion-exchange parameters such as the exchange capacities and the selectivity of soil exchange media. The experimental results indicated that certain organic compounds were irreversibly adsorbed on soil particle surfaces and had considerable effects on their ion-exchange parameters. Irreversible adsorption of organic compounds not only reduced the effective exchange capacities, but also changed the selective properties of the exchange media. In general, the selectivity for a cation in preference to others increased as soil particle surfaces were covered with organic compounds. The experimental results with natural organic extracts indicated that the effects of the extracts were similar to those of weak chelating agents. The degree of the effects was somewhat less than that of pure chelating agents used. As a result of the inefficient method of extraction used, the extracts are believed to contain only a small fraction of the natural organic compounds present in the original sample. (auth)

40985 SEPARATION OF ELEMENTS IN A LIQUID HYDROGEN FLUORIDE. Opalovskii, A. A.; Tychinskaya, I. I. (Inst. of Inorganic Chemistry, Novosibirsk, USSR). 21p. (In Russian and German). (CONF-650939-6). DTIE.

Data are given for the separation of Ge from Si by dissolving their gaseous fluorides in liquid HF. The separation coefficient in 96% HF is 500 or more. Liquid HF was also used for separation of Si from B with the B content in received Si being reduced more than 10,000 times. The possibility of using this type separation process for the separation of Th and U from Pb and Mo is also considered. The process is applicable to either solid or gaseous fluorides. (B.L.M.)

40986 TREATMENT AND DISPOSAL OF RADIOACTIVE WASTE IN AN INDUSTRIAL LABORATORY. Goette, Hans; Talsky, Josef (Farbwerke Hoechst AG, Frankfurt am Main). 12p. (CONF-670523-1). DTIE.

From 22nd Annual Purdue Industrial Waste Conference, Lafayette, Ind.

A survey of the installation and tasks of the radiochemical laboratory of Farbwerke Hoechst AG is presented. The physical plant is described in some detail. The discussion of waste disposal is introduced by a tabulation of types of waste, source, and method of treatment. Each type of waste treatment and disposal is then discussed in detail. Various aspects of radiation protection are also discussed. (B.L.M.)

40987 IMPROVEMENTS IN AND RELATING TO THE EXTRACTION OF CESIUM FROM AQUEOUS SOLUTION CONTAINING OTHER ELEMENTS. Laveissiere, Francoise; Bonnin, Andre; Poirjer, Phillipe (to Societe Saint Gobain Techniques Nouvelles). British Patent 1,079,320. Aug. 16, 1967. Priority date Oct. 1, 1963, France.

A process for separating Cs from other elements, particularly fission products, consists of the formation of a dispersion of mixed ferrocyanides of monovalent cations and cations of the transition elements, flocculation of the dispersion by means of a quaternary ammonium salt, extraction of the flocculant material from the aqueous phase into an organic phase, and re-extraction of the Cs from the organic phase by means of an aqueous phase in the presence of CN^- and a quaternary ammonium salt. The preferred quaternary ammonium salts are laurylbenzyldimethylammonium chloride or dilauryldimethylammonium chloride. (B.L.M.)

40988 IMPROVEMENTS IN OR RELATING TO CHEMICAL PROCESSING PLANT. (to United Kingdom Atomic Energy Authority). British Patent 1,079,353. Aug. 16, 1967. Filed May 3, 1965.

A basket was developed for an acid dissolver for a chemical plant in which irradiated nuclear fuel materials of the uranium metal or uranium oxide type are reprocessed. The basket comprises an outer casing and an inner casing with a layer of corrugated gauze between the casings. Each casing has a multiplicity of perforations through it. (B.L.M.

40989 IMPROVEMENTS IN OR RELATING TO THE PROCESSING OF IRRADIATED NUCLEAR FUELS. De Nordwall,

Herman John; Healy, Thomas Victor (to United Kingdom Atomic Authority). British Patent 1,079,901. Aug. 16, 1967. Filed July 1, 1963.

A process for the extraction and purification of Sr from fission-product solutions consists of treating the fission-product solution with HNO_3 to yield a solution 15 to 17N with respect to HNO_3 and to precipitate the nitrates of Sr and Ba, and then treating this combined precipitate with dilute HNO_3 to leach the Sr nitrate from the precipitate. The precipitation is carried out at 55°C and the leaching is best effected with 5N HNO_3. (B.L.M.)

40990 METHOD OF SEPARATING PLUTONIUM FROM URANIUM. (to United States Atomic Energy Commission). British Patent 1,080,449. Aug. 23, 1967. Priority date Mar. 10, 1965, United States.

A process is described for separating U and Pu values after they are extracted into a water-immiscible organic solution of TBP from an aqueous solution. The organic solution containing both the Pu and U is contacted with an aqueous stripping solution and a reducing agent capable of selectively reducing Pu to the trivalent state so that the reduced Pu is selectively transferred into the aqueous stripping solution. The reducing agent is a gaseous mixture containing H_2 in contact with a hydrogenation catalyst, such as platinized alumina. (B.L.M.)

40991 PROCESS FOR THE PURIFICATION OF SOLVENTS. Auchapt, Pierre; Girard, Bernard; Sautray, Roger (to Commissariat a l'Energie Atomique). British Patent 1,081,354. Aug. 31, 1967. Priority date Dec. 31, 1963, France.

A steam distillation process is described for particular application to the purification and decontamination of solvents employed in the nuclear industries. Uranyl nitrate is added to the solvent to be purified until the U content of the resulting mixture is less than 20 g/l, and the solvent is contacted with steam until the solvent volume is reduced to a volume that corresponds to a maximum of 2% of its initial volume. Steam distillation is carried out at a temperature within the range of 100 to 160°C under atmospheric pressure or under an absolute pressure within the range from 50 to 400 mm Hg. (B.L.M.)

EARTH SCIENCES

Geology

Refer also to abstracts 41047, 41055, and 41186.

40992 (AD-648810) CONCENTRATION OF RADIOACTIVE ISOTOPES IN ENVIRONMENTAL WATER MEASURED BY UNDERWATER GAMMA SPECTROMETRY. Riel, Gordon K. (Naval Ordnance Lab., White Oak, Md.). Dec. 20, 1966. 208p. CFSTI.

Gamma ray spectrometers were used to measure the concentrations of radioactive isotopes in dilute solutions. Their sensitivity for detection of ^{137}Cs in the ocean is about one picocurie per liter. In rivers serving nuclear reactors concentrations of less than 10 picocuries per liter of artificial radioactive isotopes were measured against a natural background of more than 100 picocuries per liter. (auth) (TAB)

40993 (DP-MS-67-55) MOVEMENT OF WATER TAGGED WITH ^{2}H, ^{3}H, AND ^{18}O THROUGH ACIDIC KAOLINITIC SOIL. Corey, John C.; Horton, J. H. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Aug. 22, 1967. Contract AT(07-2)-1. 24p. (CONF-671105-1). Dep. CFSTI.

For Presentation at Meeting of the Soil Science Society of America, Washington, D. C.

Miscible displacement techniques were used to compare the behavior of deuterium, tritium, and oxygen-18 as water tracers. Displacement of a 170-ml portion of triply tagged water through a 186-cm-long column of water-saturated acidic kaolinitic soil by distilled water revealed no differences in the relative rates of movement of deuterium-, tritium-, and oxygen-18-tagged water. (auth)

40994 (RLO-1750-22(Vol.4)) ECOLOGICAL STUDIES OF RADIOACTIVITY IN THE COLUMBIA RIVER ESTUARY AND ADJACENT PACIFIC OCEAN. Progress Report, July 1, 1966–June 30, 1967. Osterberg, Charles L. (Oregon State Univ., Corvallis. Dept. of Oceanography). Contract AT(45-1)-1750. 305p. Dep. CFSTI.

Three papers are included in the report. A separate abstract was prepared for each paper. (J.R.D.)

For abstracts of individual papers see: 40995, 40996, and 41022.

40995 (RLO-1750-22(Vol.4), Paper 1) TECHNIQUES OF SOLVENT EXTRACTION OF ORGANIC MATERIAL FROM NATURAL WATERS. Cronin II, John Thomas (Oregon State Univ., Corvallis. Dept. of Oceanography). June 1967. 79p.

Thesis.

Efforts devoted to development of solvent extraction methods for separation of organic matter from natural waters are described. Procedures used for samples from the Columbia River estuary at Astoria, Oregon, including sampling, radioanalysis, gas chromatography, mass spectroscopy, and infrared spectroscopy are described. Procedures are also described for adsorption chromatography using silicic acid columns and hexane separations. A laboratory analytical scheme is diagrammed. Results indicate that solvent extractions are successful in removing organic materials from natural waters. (J.R.D.)

40996 (RLO-1750-22(Vol.4), Paper 3) ^{51}Cr IN THE COLUMBIA RIVER AND ADJACENT PACIFIC OCEAN. Cutshall, Norman Hollis (Oregon State Univ., Corvallis. Dept. of Oceanography). June 1967. 64p.

Thesis.

Results of investigations aimed at determining factors affecting fractionation of ^{51}Cr from the Hanford effluent are presented. Radioanalytical methods using gamma spectroscopy are described. Sorption of ^{51}Cr on solids is discussed along with sediment uptake experiments and desorption experiments. Electrodialysis and sedimentation fractionation experiments are also described along with ^{51}Cr measurements in seawater. Clarity, low temperature, and low biological oxygen demand were found to be desirable for rapid and complete dispersion of ^{51}Cr in water. (J.R.D.)

40997 (AEC-tr-6899) USE OF THE SIMILARITY THEORY IN THE GAMMA METHOD OF DETERMINING DENSITY. Artzibashev, V. A. Translated from Vop. Rud. Geofiz., Gos. Geol. Kom. SSSR, No. 5, 88-95(1965). 14p. Dep. CFSTI. JCL $2.60 fs, $0.80 mf.

The most effective use of the principles of similarity during the standardization of problems and generalization of materials in the gamma-method of density measurement is possible when the equation of gamma-field can be presented in the invariant form. Under these conditions the gamma-field is determined by two invariant complexes – the extinction factor and the surface density of the absorbing layer. The region of utilization of similar transformation of gamma-field related to the density change of the media and the intensity of the source of radiation considerably widens if one is limited by the approximate fulfillment of the requirements of the theory of similarity. Experiments partially confirmed that it is possible to violate geometrical similarity of the sound measuring system or media, and also the permissible violation of the geometrical similarity when the homogeneous media are replaced by the layer-type media. (F.S.)

40998 (AEC-tr-6900) ESTIMATION OF THE EFFECT OF EMANATION FROM RADIOACTIVE ORES ON THE RESULTS OF GAMMA-ASSAYING OF ORES IN THEIR NATURAL DEPOSITS. Bolotnikov, A. N. Translated from Vop. Rud. Geofiz., Gos. Geol. Kom. SSSR, No. 5, 52-62(1965). 4p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

In the interpretation of results of gamma-assaying of radioactive ores, it is necessary to take into account the loss of radon and its decomposition products in their natural ore deposits. The corrected magnitude necessary for the emanation must be determined directly in its natural deposits by hermetically sealing the ore surface sector. The limits of radon escape and its corresponding emanation correction are evaluated by the known parameters K_{eman}, D and μ. (F.S.)

40999 (AEC-tr-6901) ON THE THEORY OF THE HELIUM METHOD OF PROSPECTING FOR DEPOSITS OF RADIOACTIVE ELEMENTS. Grammakov, A. G.; Glebovskaya, V. S.; Khaikovich, I. M. Translated from Vop. Rud. Geofiz., Gos. Geol. Kom. SSSR, No. 5, 3-19(1965). 26p. Dep. CFSTI. JCL $2.60 fs, $0.98 mf.

An evaluation is given of the Foehn concentration of helium underground and the calculation of possible concentrations of helium is presented above the range of horizontally occurring ore bodies and the breaking zone. (L.C.L.)

41000 (AEC-tr-6904) ATTEMPT TO USE THE GAMMA-RAY REFLECTION METHOD FOR QUANTITATIVE DETERMINATION OF IRON IN UNDERGROUND BOREHOLES IN THE ORDZHONIKIDZE MINE IN THE KRIVOY ROG BASIN. Ochkur, A. P.; Pshenichnii, G. A.; Komissarzhevskaya, G. F.; Orlov, V. N. Translated from Vop. Rud. Geofiz., Gos. Geol. Kom. SSSR, No. 5, 109-12(1965). 6p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

A gamma-ray reflection method was developed for determining the separation of ore bodies and the iron content in underground boreholes. Experimental results with the reflection method were compared with the chemical analyses of core samplings and were found to correlate within 3%. (L.C.L.)

41001 STUDIES ON STATISTICAL PHENOMENA IN THE HYGIENIC-CHEMISTRY FIELD AND ON THEIR APPLICATIONS. XII. RADIOACTIVITIES IN CITY WATERS. Suzuki, Noboru (Shizuoka Prefecture Hygienic Research Lab., Japan). Mizu Shori Gijutsu, 7: 51-2(Apr. 1966). (In Japanese).

The radioactivity removal rates from source water to tap water, in the centralized waterworks and in the independent home water works were examined. The two types of waterworks were compared as to the radioactivity removal rates. In the study, data obtained from 1959 to 1961 were employed. The results obtained are as follows: 64.8% ± 19.5 of the original radioactivity was removed in the centralized waterworks, and in the independent home waterworks approximately 87.8%, there was no significant difference between the removal rates of the two types, the radioactivities in the centralized and the home waterworks were both below 1 Cipm/l tap water on the average. The activities in rainwater and well water were far lower than the standard 14 ~ 40 Cipm/l. (NSA of Japan)

41002 RADIOACTIVITY OF SEA WATER AROUND KOBE HARBOR. II. Miyake, Hiroshi; Michijima, Masami (Kobe Univ., Japan). Kobe Shosen Daigaku Kiyo. Dai-2-Rui. Kohai, Kikan, Rigaku-Hen, No. 13, 125-30(Mar. 1966). (In Japanese).

From 1961 to 1965, radioactivities about Kobe Harbor were investigated. Samples were taken from three different places, i.e., surface sea water, sea water at 10 m depth, and deposits on the bottom. For the measurements, 5-liters of sea water were treated by coprecipitation with iron, and the 20g deposit sample was dried at 110°C and treated with HCl; β-ray measurements were done for these samples. No correlation was observed between the surface water and the 10-m deep water samples, but was found for the deposits sample. ^{90}Sr and ^{137}Cs were determined for sea water in a pond of the college, the deposit, and the water of River Takahashi. About Kobe Harbor, there was no abnormality in the radioactive intensity. The X-ray film examination showed that radioactivity

concentrated at points, exceeding several tens of μμC in some cases. Therefore, care must be taken in the sample preparation. Since fallout nuclides reportedly form particles, it is necessary to measure both by counters and by radioautography. (NSA of Japan)

41003 AERIAL RADIOMETRY. Diez Serrano, D. (Junta de Energia Nuclear, Madrid). Energ. Nucl. (Madrid), 11: No. 45, 47-56(Jan.-Feb. 1967). (In Spanish).

Aerial radiometry is used in general prospection of radioactive minerals and has its own particular techniques. The employment of these techniques and their utilization are outlined. (J.S.R.)

41004 URANIUM SUPPLY AND DEMAND. Ball, G. R. (Denison Mines, Can.). Nucl. Eng., 12: 609-11(Aug. 1967).

The three most important factors in considering world uranium supplies are demand, burn-up, and price. A flexible computer program is described which can take these and many other factors into account and predict trends in spot prices. Input information was classified into four general categories: country demand configuration, new contracts, existing contracts, and mine production. Results are illustrated by graphs showing world price movement in the 1970s. (UK)

41005 COMMUNICATION ON THE GROUND WATER COMPONENT OF RIVER DISCHARGE AND ITS RELATIONSHIP TO HYDROGEOLOGY. Balek, J.; Ralkova, J. (Inst. of Hydrodynamics, Prague). J. Inst. Water Eng., 19: 486-8(Oct. 1965).

Measurements of fallout radionuclides were made by β assay in the course of investigating a simple, approximate method of separating ground-water flow from interflow and surface run-off by utilizing the low-level radioactivity present in natural waters. The method was tested in Czechoslovakia on the experimental basin of the Volynka River (382 km^2). Measurements of low-level radioactivity in water led to the development of a method for separating surface run-off from ground-water discharge by making use of the higher radioactivity of surface run-off. The method was based on the proposition that soils adsorbed most of the radioactivity of that part of rainfall which contributed to ground-water discharge, while the radioactivity of surface run-off remained unchanged during the period of intense rainfall. As a result of nuclear explosions, rain nearly always contained fission products, and the β activity was high enough to be measured. Experiments were carried out to determine the β activity of rainfall which occurred during storms and that of the resulting flood water. Adsorption of radioisotopes by different types of soil from the experimental basin was also studied. Lab experiments included comparison of the effect of shaking soil samples with a solution of the fission products, and permitting a similar solution to percolate through a column of the same soil samples. A high adsorption of radionuclides was observed except for anionic nuclides, but the radiation from these represented less than 5% of the total radioactivity with a half life of 0.5 to 10 yr. Moreover, radiation from ^{3}H, which could pass through soil, was very low, and could not be detected by ordinary monitoring equipment. Radioactivities of rain and river water were estimated by direct monitoring of the liquid, using a low-level activity scintillation counter. This method of direct measurement eliminated radioactivity losses through evaporation and sublimation. (BBB)

41006 THE USE OF RADIOACTIVE ISOTOPES IN HYDROLOGY. VI. THE INFLUENCE OF THE FILTER TUBE ON THE DETERMINATION OF FILTRATION VELOCITY BY THE POINT DILUTION METHOD. Koch, Arnd; Klotz, Dietmar; Moser, Heribert (Institut fuer Radiohydrometrie der Gesellschaft fuer Strahlenforschung mbH, Munich). Atomkernenergie, 12: 361-70 (1967). (In German).

For measuring the filtration velocity of an undisturbed groundwater flow, the distortion of the flow field by the filter gauge must be known, a special allowance must be made for the influence of the filter tube. It has been manifested that the filter tube perforation alone is not suitable for describing this influence. Numerous experiments in two- and three-dimensional flow models showed that a definite permeability can be attributed to the filter tube as well as to the porous medium. For a number of filter tubes the permeability was determined in model experiments. The theory of pipe flow was transferred to the filter tube slots, furnishing a theoretical representation of the filter tube permeability. Therefrom, the distortion of the flow field by the filter gauge can be calculated according to known theoretical expressions. Suggestions relating to the appropriate construction of filter tubes are deduced from theory. (tr-auth)

41007 ERRONEOUS CONVERSION OF CARBON ISOTOPE DATA: COMMENTS ON A PAPER BY CHENEY AND JENSEN (1965). Weber J. N.; Deines, P. (Pennsylvania State Univ., University Park). Geochim. Cosmochim. Acta, 31: 1343-4 (Aug. 1967).

An erroneous conversion procedure used to compare carbon isotope ratio measurements reported in different notation by different authors has been corrected. (auth) (UK)

41008 URANIUM AND THORIUM SERIES DISEQUILIBRIA IN RECENT AND FOSSIL MARINE MOLLUSCAN SHELLS. Blanchard, R. L.; Cheng, M. H.; Potratz, H. A. (Washington Univ., St. Louis). J. Geophys. Res., 72: 4745-57(Sept. 15, 1967).

The extent of disequilibrium between certain members of the naturally occurring radioactive heavy element families in recent and fossil marine molluscan shells has been investigated with a view to ascertaining the conditions under which these disequilibria may serve as measures of geologic age. The results obtained lead to the following conclusions. The average uranium concentration in fossil marine shells is generally higher than in modern shells from the same region. Greater than equilibrium quantities of ^{226}Ra are present in most modern marine shells. The predominant thorium alpha activity in shells of living marine mollusks is associated with ^{228}Th, which presumably arises from decay of ^{228}Ra in the specimen. The ^{230}Th concentration in modern marine shells is near zero and is probably less than 1% of the equilibrium quantity. Uranium and thorium compositions of fossil marine molluscan shells collected from terrestrial environments have generally been altered by contact with ground waters. For this reason, age determination of fossil marine carbonates by uranium decay series disequilibrium measurements, although apparently sometimes applicable to fossil corals and other fossil marine carbonates that have formed and have remained in a marine environment, is not likely to give reliable results when applied to isolated fossil marine shell specimens collected from terrestrial environments. (auth)

41009 METODICHESKIE VOPROSY IZOTOPNOI GEOLOGII. (Problems of Methodology in Isotope Geology). Shcherbakov, D. I. (ed.). Moscow, Izdatel'stvo Nauka, 1965. 163p.

Eighteen articles are included on the application of physical and chemical methods to geochronology. Mass spectrometric determination of lead, uranium and thorium in ores and minerals is discussed. A detailed study was made of absolute age determination by radiogenic argon, ion, helium, radiocarbon, lead, and strontium methods. A brief review is also given on other dating methods including the rhenium–osmium method, nuclear fission process, fluorine method, and age determination by means of $^{231}Pa/^{230}Th$, $^{234}U/^{238}U$ and ^{239}U ratios. The results of various methods are evaluated and a geochronological scale given. Regional data on age determinations are given for the north European USSR region, Ukrainian and central European region, and southern region of the USSR. The age data are also given for the Urals, Kazakhstan, Transbaikal and Far East regions, as well as for northern and central Europe, Asia, North America, Canada, Central and South America, Africa, Antarctic, Arctic, Australia, and New Zealand. 660 references are included. (R.V.J.)

Meteorology

Refer also to abstracts 41059, 41061, and 41186.

41010 (BMI–171-001) RADIONUCLIDE BEHAVIOR AND DISTRIBUTION IN TROPICAL FORESTS. Bioenvironmental and Radiological-Safety Feasibility Studies, Atlantic–Pacific Interoceanic Canal. Kline, Jerry R. (Battelle Memorial Inst., Columbus, Ohio). Nov. 1, 1966. Contract AT(26-1)-171. 20p. Dep. CFSTI.

Fallout radionuclides in forests of Darien, Panama, were found to be lower by approximately a factor of ten than those in the forests of Puerto Rico. These findings are consistent with previously reported results of the 80th meridian survey, which indicate that airborne radioactivity declines rapidly from north to south in the Northern Hemisphere. However, the distribution of radionuclides among various vegetational types was similar to that found in Puerto Rico. Lowland forests were invariably the least contaminated and the contamination levels generally increased in forests with increasing altitude. Plants which have an epiphytic growth habit were found to be apparent accumulators of fallout nuclides in all forest types. A variety of foods collected in Panama were found to have fallout radionuclide burdens which were lower by a factor of ten than forest vegetation of the immediate environment. A tracer experiment carried out on understory vegetation at the El Verde experimental site in Puerto Rico using the nuclides ^{134}Cs, ^{85}Sr, and ^{54}Mn indicated extremely slow uptake by the plants. The results of this experiment suggest that the high levels of fallout radionuclides found in the El Verde forest in both understory and crown vegetation cannot be accounted for

on the basis of recycling of these nuclides through roots but is more likely the result of interception on surfaces from rainfall. (auth)

41011 (BNWL-SA-1400) VARIATION OF CONCENTRATION IN PLUMES AND BUILDING WAKES. Hinds, W. T. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sept. 5, 1967. Contract AT(45-1)-1830. 41p. (CONF-670931-7). Dep. CFSTI.

From USAEC Meteorological Information Meeting, Chalk River, Ontario, Canada.

A short series of experiments to define the effect of wake flow on the variance of concentration is described. The time history of concentration at a point in building wakes from ground level sources was found to differ little from that observed in a plume from a point source. An approximate power law dependence of peak to mean ratios on averaging interval was observed in both wakes and unobstructed plumes, but ground level sources in wake flow yielded peak to mean ratios comparable to those observed from unobstructed elevated sources. Thus, it is surmised that elevated releases into wake flow probably will yield greater peak to mean ratios than unobstructed elevated sources. (auth)

41012 (BNWL-SA-1401) THE MOUNTAIN IRON DIFFUSION PROGRAM. Hinds, W. T. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sept. 5, 1967. Contract AT(45-1)-1830. 30p. (CONF-670931-8). Dep. CFSTI.

From USAEC Meteorological Information Meeting, Chalk River, Ontario, Canada.

From November, 1965 through July, 1966, a large-scale program designed to illuminate the diffusion characteristics of marine air over coastal range mountains was carried out in Southern California, at Vandenberg Air Force Base. The experimental design for this program is outlined, and salient features of diffusion analysis are presented. The technique developed for predicting plume width, based on the Hay-Pasquill running average method, indicated that $\beta = 200/\sigma_0$, much larger than heretofore reported for unstable conditions. The prediction of centerline exposures over mountainous terrain was shown to be dependent upon temperature stratification in a different manner than observed over level terrain, and that exposures were generally lower and less dependent upon both season and time of day over mountainous country. (auth)

41013 (BNWL-SA-1402) PRECIPITATION SCAVENGING OF SUBMICRON PARTICLES. PART A. THEORY. Slinn, W. G. N. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sept. 5, 1967. Contract AT(45-1)-1830. 14p. (CONF-670931-10). Dep. CFSTI.

From USAEC Meteorological Information Meeting, Chalk River, Ontario, Canada.

For the precipitation scavenging of submicron particles, inertial effects are shown to be negligible by transforming Newton's law to the mass independent Smoluchowski equation. The importance of electrical effects can be displayed theoretically but its evaluation requires more specific information about the charges on raindrops and particles. Heat transfer data are utilized to calculate the washout coefficient and the result is found to be a factor of two to ten below Ziman's. (auth)

41014 (BNWL-SA-1405) PRECIPITATION SCAVENGING OF SUBMICRON PARTICLES. PART B. COMPARISON OF THEORY WITH FIELD EXPERIMENTS. Hagen, D. I. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sept. 5, 1967. Contract AT(45-1)-1830. 12p. (CONF-670931-6). Dep. CFSTI.

From USAEC Meteorological Information Meeting, Chalk River, Ontario, Canada.

Calculations based on convective and Brownian diffusion are found to predict within experimental error the rain washout coefficients measured in the field for sub-micron silver iodide particles. These particles, similar to those used in cloud seeding work, have a log normal distribution with geometric mean diameter of .012 μ. (auth)

41015 (BNWL-SA-1406) VARIANCE OF AN INCREASINGLY SMOOTHED RANDOM VARIABLE. Hinds, W. T. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sept. 5, 1967. Contract AT(45-1)-1830. 14p. (CONF-670931-9). Dep. CFSTI.

From USAEC Meteorological Information Meeting, Chalk River, Ontario, Canada.

The rate of decrease of the variance of a stationary random function with increasing smoothing is examined from the viewpoint of the definition of variance. Assuming the smoothing interval, t, to be small with respect to the length of record, and the variance to be calculated from overlapping running means, it is shown that the variance, σ_s^2, is related to smoothing interval by $d\sigma_s^2/\sigma_{s,0}^2 = 2\,[(P(t/2)/\sigma_s^2) - 1]\,dt/t$ where P(t/2) is the autocovariance at lag t/2. Semi-empirical forms for P(t/2) are shown to provide a good fit for results from time series of both Gaussian and non-Gaussian distributions, and to yield fair estimates of the autocovariance as a function of lag time. (auth)

41016 (BNWL-SA-1407) REAL TIME SAMPLING OF ZINC SULFIDE TRACER IN DIFFUSION STUDIES. Dotson, W. L.; Nickola, P. W.; Wolf, M. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sept. 5, 1967. Contract AT(45-1)-1830. 19p. (CONF-670931-4). Dep. CFSTI.

From USAEC Meteorological Information Meeting, Chalk River, Ontario, Canada.

A real time sampler has been developed for the measurement of instantaneous atmospheric concentrations of zinc sulfide particulates. The requirements for such an instrument and its subsequent evolution for both surface and airborne applications are presented. Salient features of real time sampler records from several diffusion tests are discussed. The airborne instrument is shown to provide vertical definition of the tracer distribution which is not otherwise available. Comparisons are made of the time-integrated concentrations across the tracer plume, measured by the filter samplers of the Hanford diffusion grid, and the "instantaneous" cross-plume concentrations defined by the real time samplers. The instantaneous properties of the continuous plume emphasize the local influences which perturb the mean flow, while the relationship of the instantaneous properties to the time-averaged properties provide additional insight into the nature of the instantaneously generated puff. An improved airborne real time sampler, which is nearly ready for testing, has been modified to extend its usefulness by reduction of spurious signals. (auth)

41017 (CONF-670931-1) LONG RANGE TRAJECTORIES. Allen, P. W.; Jessup, E. A.; White, R. E. (Environmental Science Services Administration, Las Vegas, Nev. Air Resources Field Research Office). [1967]. 19p. Dep. CFSTI.

From USAEC Meteorological Information Meeting, Chalk River, Ontario, Canada.

A series of 444 trajectory forecasts originating in southern Nevada at 10 and 12 thousand feet and prepared routinely by The Air Resources Field Research Office forecasters have been compared with trajectories which were reconstructed from wind data with standard vector differences of approximately half of the trajectory length. Reconstructed trajectories were compared with a smaller number of tetroon trajectories, showing large standard vector deviations. Dispersion of tetroon clusters can account for only ⅓ to ⅛ of the deviation of the reconstructed trajectories. Graphs are illustrated for estimating the standard vector error of trajectory forecasts. Most of the difficulty in trajectory prediction and construction is attributed to the complexity of flow over mountain ridges and the inadequacy of network wind data in the intermountain area. (auth)

41018 (DP-MS-67-69) SITE EVALUATION USING MEASURED METEOROLOGY DATA. Cooper, R. E.; Rusche, B. C. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Sept. 1967. Contract AT(07-2)-1. 16p. (CONF-670931-3). Dep. CFSTI.

From USAEC Meteorological Information Meeting, Chalk River, Ontario, Canada.

A key factor in reactor site evaluation is the frequency of occurrence of various dispersion conditions and this relationship to potential off-site radiation doses following a reactor accident. Detailed measurements of the wind speed, wind direction, and temperature at heights up to 1200 ft at the Savannah River Plant form the basis for a comprehensive analysis of the frequency of occurrence of potential off-site doses. A complete set of data was taken about every five minutes, and 107,000 sets (about one year of data) were analyzed. The meteorology data were converted to ordinary dispersion parameters through correlating equations. The results were expressed on curves in dose per unit release of activity vs distance from the reactor with probability of occurrence as a parameter. Separate sets of curves were calculated for releases of noble gas and of halogens and at release heights of 200 ft (a nominal stack height) and of 850 ft (about the height of the tallest power plant stacks). Additional curves were developed to show dose as a function of direction and probability of occurrence. In addition to the dose frequency distribution analyses performed as a function of height of release, direction, and distance; more conventional frequency distributions of wind speed, wind direction, and thermal stability were developed as a function of height. All the analyses were carried out on the IBM 360/65. These results represent the first known analysis utilizing data up to 1200 ft and taken often enough to develop reliable frequency distributions for a short term release. (auth)

41019 (HASL–182) FALLOUT PROGRAM QUARTERLY SUMMARY REPORT, MARCH 1, 1967–JUNE 1, 1967. Hardy, Edward P. Jr.; Rivera, Joseph (New York Operations Office (AEC), N. Y. Health and Safety Lab.). July 1, 1967. 167p. Dep. CFSTI.

Current data are presented from the HASL Fallout Program, Isotopes, Inc., Euratom Joint Nuclear Research Center, Argonne National Laboratory, and the National Radiation Laboratory in New Zealand. Radionuclide levels in stratospheric air, surface air, fallout, milk, other diet components, and tap water, are given in tabular form. Interpretative reports and notes are included covering fallout of SNAP-9A debris; the ratio of ^{137}Cs to ^{90}Sr in monthly fallout; and strontium-90 in human vertebrae. A bibliography of recent publications related to radionuclide studies is also presented. For data appendixes see HASL-182(App.). (auth)

41020 (HASL–182(App.)) FALLOUT PROGRAM QUARTERLY SUMMARY REPORT, MARCH 1, 1967–JUNE 1, 1967. (New York Operations Office (AEC), N. Y. Health and Safety Lab.). July 1, 1967. 204p. Dep. CFSTI.

Data tabulations for HASL-182 are presented on radioisotope depositions at global sampling stations. (J.R.D.)

41021 (NP–17016) MEASUREMENTS OF FISSION PRODUCT ACTIVITY IN AIR AND IN PRECIPITATION UP TO 31 DECEMBER 1966. Report No. 26. (Forsvarets Forskningsrad, Copenhagen (Denmark)). Apr. 1967. 19p. Dep.

Data from measurements of fission product fallout in ground level air and in precipitation in Denmark during the second half of 1966 is presented. Current data on total air activity, cesium-137 and strontium-90 content in precipitation, and lanthanum-140 content in ground level air are plotted with similar data for 1961 through 1966. (L.C.L.)

41022 (RLO–1750–22(Vol.4), Paper 2) DISPERSION OF THE COLUMBIA RIVER PLUME BASED ON RADIOACTIVITY MEASUREMENTS. Frederick, Lawrence Churchill (Oregon State Univ., Corvallis. Dept. of Oceanography). June 1967. 134p.

Thesis.

Measurements of ^{51}Cr dispersion in the sea in the area of the Columbia River Estuary are presented and discussed. Samples obtained in summer and winter cruises were analyzed aboard ship. The results were used as a basis for the cruise plan. Results show the feasibility of following the river effluent at sea regardless of season. Techniques were developed which can be used to define the pattern of the river plume and assist in determining rates of dispersion. (J.R.D.)

41023 NATURAL RADIOACTIVITIES IN FLOATING DUSTS AND RADIOACTIVITIES IN FALLOUT FROM THE SECOND CHINESE NUCLEAR EXPLOSION. Oshino, Akira; Oki, Iwashiro (Osaka Public Health Inst.). Osaka-Furitsu Koshueisei Kenkyusho Kenkyu Hokoku, No. 3, 85-8(Mar. 1966). (In Japanese).

Although the effect of radiations on the human body should be considered in terms of total dose accumulated over a long period of time, a rapid determination is required for such occasions as nuclear explosion tests, when administrative measures must be taken. The variation in the natural radioactivities and the radioactivities in fallout due to the second Chinese nuclear explosion (May 14, 1965) were investigated and compared with those for the first Chinese nuclear explosion and for the Russian underground explosions. The following conclusions were reached: the estimated radioactive contamination for such occasions depends considerably on the type and on the method of sampling, particularly in samples collected over short periods; the natural radioactivity in floating dusts is subject to a regular change of cycle of about 24 hours, depending on rainfall; and the effect of the second Chinese nuclear test was detected about 72 hours after the explosion. (NSA of Japan)

41024 RADIOACTIVE FALLOUT PARTICLES FROM THE CHINESE NUCLEAR DETONATION. III. Mamuro, Tetsuo (Radiation Center of Osaka Prefecture, Japan). Mizu Shori Gijutsu, 7: 21-4(Aug. 1966). (In Japanese).

The species and composition of fallout particles due to the first Chinese nuclear detonation were investigated by X-ray fluorescent analysis. The investigation was made on 21 particles, and the presence of Fe, Ca, Si, Al, K, Mn and Ti were confirmed. The particles were classified into two groups, namely, red-brown and colorless spherical particles. More Fe was found in the former group, but the contents of Ga and Si were larger in the latter. Al and K existed in the former but not in the latter. The phosphorus content was higher in the former group than in the latter. The main constituent elements in the particles were Fe, Ca, Si and Al. The color was darker with higher Fe contents. The distribution of the main elements in the particles was also investigated. (NSA of Japan)

41025 RADIOACTIVITY IN AIR, ATMOSPHERIC PRECIPITATIONS, AND FALLOUT IN BERLIN–FRIEDRICHSHAGEN FROM 1959 TO 1966. Blume, W.; Zindler, H. (Staatliche Zentrale fuer Strahlenschutz, Berlin). Kernenergie, 10: 223-9(July 1967). (In German).

The contamination of the atmosphere (air, precipitation, fallout) in Berlin–Friedrichshagen from 1959 to 1966 as a result of nuclear tests is discussed. The methods used for measuring the total beta activity and for measuring the ^{90}Sr and ^{89}Sr contents are briefly described. The results are presented. On the basis of the percentage of ^{90}Sr of the total activity and the $^{89}Sr/^{90}Sr$ ratio age and origin of the fission products deposited are discussed. (tr-auth)

41026 TRANSPORT OF RADIOACTIVE AEROSOLS ACROSS THE TRADE WIND INVERSION AT HAWAII. Kruger, Paul (Stanford Univ., Calif.). Tellus, 19: 380-91(1967).

Radioactivity concentration measurements in aerosol and precipitation samples collected along the slopes of Mauna Loa volcano in Hawaii have been examined in relation to vertical profiles of temperature and humidity in the atmosphere across the trade wind inversion. The gradient of radioactive aerosol concentration in the air with height is related to the humidity profile and the character of the trade wind inversion. The concentrations increased with height across the trade wind inversion in contrast to aerosols of terrestrial origin whose concentrations in air decreased with height. The concentrations in rainfall generally decreased with height, except for an anomolous result at 2250 m, just below the trade wind inversion. At this altitude, the gross radioactivity concentration increased while the ^{90}Sr concentration decreased. The ratio of the gross beta concentration in air and rain gives a parameter with dimensions of mixing ratio, which may be of potential use in determining rainout efficiencies. (auth)

41027 TOWARD MORE REALISTIC SYSTEMS FOR THE DISCHARGE OF RADIOACTIVE AIRBORNE WASTES. Dunster, H. J. (Atomic Energy Research Establishment, Harwell, Eng.). Health Phys., 13: 916(Aug. 1967).

It is contended that it is almost always wrong to apply the control of gaseous (or liquid) wastes in terms of concentration at the point of discharge. This makes no allowance for subsequent dilution, or reconcentration, in the environment. Usually this method gives an over-safe answer. For large-volume wastes containing a nuclide which is heavily concentrated in the environment it may, however, underestimate the hazard. Except where there is direct exposure to the undiluted waste, the method is at best illogical and at worst hazardous. Waste disposal assessment and control should be based on a study of the various pathways by which radioactivity can be transmitted to man. A simple review will usually establish the critical route, and control measures should be related to this. In agricultural areas, deposition and passage through food chains may be important and will often be more limiting than inhalation. There is also a need for a simple series of control figures for the guidance of small isotope users who do not wish to be involved in environmental studies. These control figures should meet three conditions: they must be safe in all reasonable circumstances—they will then be very conservative in most situations, there must be an easy administrative procedure for replacing them by more realistic figures based on proper assessment of the environment, they should be expressed in units of activity per unit time, possibly in curies per week—a compromise between the need for operational flexibility and the objections to high transient concentrations. (UK)

41028 PROBLEM OF THE RELATION BETWEEN THE AMOUNT OF DUST AND RADIOACTIVE AEROSOLS IN ATMOSPHERE. Matousek, J.; Mertl, F.; Patocka, S. (Inst. of Physics, Charles Univ., Plzen, Czech.). Cesk. Hyg., 12: 138-43(Apr. 1967). (In Czech).

Results are presented of 1 yr observations in the Plzen area (from September 1963 to August 1964) on correlations between atmospheric dust levels, dust fallout, and atmospheric β radioactivity. Direct correlation between the whole-year values of radioactive and dust fallout at different places in Plzen was found. The month-dependent relation of the fallout and aerosol radioactivity, on the amounts (wt) of circulating and sedimented dust particles, respectively, was particularly pronounced in spring and summer season, whereas in autumn and winter the activity of both the constituents was relatively low. The dust radioactivity reached a maximum level of 16 mCi/km^2 in April 1964, whereas the maximum level of aerosol radioactivity was reached in September 1963 (2×10^{-10} Ci/m^3). (BBB)

41029 ATMOSPHERIC RADIOACTIVITY AND EXCHANGE. Israel, H.; de La Riva, C. (Technische Hochschule, Aachen). Z. Geophys., 33: 188-92(1967). (In German).

The natural radioactivity of the atmosphere has been described only for the stationary case and for emanations; a solution of the equation with a time term different from zero does not exist. Consequently an analytical solution of the stationary problem for emanations and inductions must be found. A solution is described. An example is given for the case in which i, the index for the i-th decay product, is chosen as 2. Total corrected quantities per unit volume may be estimated merely by knowing the concentration of the first component. (BBB)

41030 INFLUENCE OF RADIOACTIVE FALLOUT ON THE ATMOSPHERIC POTENTIAL GRADIENT. Hamilton, R. A.; Paren, J. G. Meteorol. Mag., 96: 81-5(Mar. 1967).

Nuclear explosions have generally been local and short-lived but have caused a marked change in the atmospheric electrical potential gradient near the ground which has persisted for some years. In some places the weather potential gradient in 1959 and 1963 was only about $\frac{1}{3}$ of its pre-1950 value. The main cause of the change appears to be the increased ionization in the air produced by β rays from fallout brought down by rain from the upper atmosphere and deposited on the ground. Measurements are described that were made at Lerwick and Eskdalemuir (Scotland) in the summer of 1964, when the radioactivity on the ground resulting from the extensive 1962 weapon testing was expected to be very high, though past its maximum. An analysis of the Lerwick rainfall for August 1964 showed that the main β-ray emitters were ^{144}Pr (2.98 MeV) and ^{144}Ce (0.32 MeV). About 44% of the β rays had energies of about 3.0 MeV and 40% in the range 0.25 to 0.65 MeV. Consideration of what would be the result of a transmission experiment on a sample containing radionuclides in the same proportion as found in the rainwater gave counting rates which agreed, within the rather large limits of statistical error, with the counter experiments with the Lerwick soil. Measurements at Lerwick showed that ionization varied from place to place, being generally 40 to 50 I (ion pairs per cm^3/sec) at 10 cm above natural peat surfaces and about 20 I in areas which had recently been dug, and, in the meteorological enclosure, lightened by the admixture of sand. It was estimated that the average ionization rate was 40 I with a mean rate of about 32 I from surface to 1 m. Measurements at Eskdalemuir in September 1964 gave 38, 35, and 43 I, or a mean value of 31 I from surface to 1 m. No correlation of potential gradient with ionization rate was noted. (BBB)

41031 INVESTIGATIONS OF RADIOACTIVE FALLOUT. IX. Mohnen, V.; Stierstadt, K. (Univ., Munich). Atomkernenergie, 12: 374-6(1967). (In German).

The results of measurements of artificial beta-activity of fallout during 1964 to 1966 are reported. The activity of the sampling device ("Sammler") decreased nearly exponentially since the middle of 1964 with a half life time of about 20 months. After each test explosion above ground we have observed small radioactive particles. (tr-auth)

41032 INVESTIGATIONS ON RADIOACTIVE AEROSOLS. Schumann, G. (Univ., Heidelberg). Chem.-Ing.-Tech., 39: 966-71(Aug. 1967). (In German).

Radioactive aerosols can cause hazards in nuclear technology. They were investigated with respect to distribution in size and activity. Mathematical relations are given for the rate of attachment of radioactive atoms and ions to atmospheric aerosol particles as a function of particle size. (auth)

41033 RISE OF STRONGLY RADIOACTIVE PLUMES. Gifford, F. A. Jr. (Atmospheric Turbulence and Diffusion Lab., Oak Ridge, Tenn.). J. Appl. Meteorol., 6: 644-9(Aug. 1967).

The presence of radioactive gases in a plume, such as could occur in the event of a nuclear reactor accident, leads to the addition of buoyancy to the plume at an approximately linear rate. Buoyancy might also be added to plumes by chemical reactions, radiation, or latent heat exchange. The resulting plume rise is calculated by a model similar to that used to calculate the rise of ordinary plumes. The case of a radioactive plume is examined in some detail. For the slow leakage of radioactive gases assumed to occur under postulated reactor accident conditions, plume rise due to radioactivity can be neglected. For more rapid leakage rates or for larger reactors, plume radioactivity leads to significant rises. (auth)

41034 MEASUREMENTS OF THE NATURAL ACTIVITY AND OF FISSION PRODUCTS OF AIR. Rissmann, S. (VEB Vakutronik Dresden). Kernenergie, 10: 198-201(June 1967). (In German).

After illustrating the fundamentals of aerosol activity measurements, the formulas for the calculation of the radon fraction in the air for discontinuous concentration are given. The monthly average and extreme values of the radon activity measured in Dresden from August 1960 to December 1965 in the morning as well as the activity of fission products in the air are presented. Factors affecting the activity are discussed. (tr-auth)

41035 INFLUENCE OF NUCLEAR EXPLOSIONS ON THE WEATHER PATTERN OF TEMPERATE EURASIA. Wick, G. M. N. Indian J. Meteorol. Geophys., 16: 285- (1965).

During the periods of nuclear explosions (9 Sept. to 4 Nov. 1961 and 5 Aug. to 25 Dec. 1962) and the post-nuclear periods (5 Nov. to 30 Nov. 1961 and 26 Dec. 1962 to 15 Jan. 1963) an abnormal pressure pattern was observed in the troposphere and lower stratosphere of the North polar regions and temperate Eurasia. It was discovered that each of the nuclear explosions had played an important role in the evolution of the abnormal circulation pattern. (Indian Sci. Abstr.)

41036 INTERACTIONS OF ^{220}Rn AND ITS DAUGHTER PRODUCTS WITH A CARBON AEROSOL. Haughey, Francis James. New Brunswick, N. J., Rutgers-The State Univ., 1966. 250p. Thesis.

A carbon aerosol (geometric mean diameter ~0.29 microns; geometric standard deviation 1.45; sample size 3602; resolution at 5500Å, 0.21 microns) was caused to interact with ^{220}Rn and daughter products in an aerosol test system. The test system consisted of a static receiving chamber, dual ^{220}Rn contact chambers, dual oscillating aerosol chambers, and dual sampling and readout equipment. The dual system permits a control to be run with each experiment. Samples were drawn from the aerosol chambers at various times following contact through separate light scattering sensing units then through six-stage cascade impactors. The signals from the light-scattering sensors were fed to separate halves of a 400 channel multichannel analyzer for particle size distribution analysis. Readout consists of typewriter, recorder, and punched paper tape for input to an IBM 1620/7040 computer for calculation of mean values and standard deviation values. Investigation consisted of studying the effect of the ^{220}Rn and daughter products on the stability of the carbon aerosol and the effect of the carbon aerosol on the daughter products. Relationships between particle concentration, particle size, total activity, specific daughter products, different sorptive surfaces and carrier gas were studied. Results showed the ^{220}Rn and daughter products were not attached to the surface of the carbon particles. The two aerosol systems remained separate with only a minor degree of interaction (<5% labeling). The lack of attachment was not related to the chemical characteristics of the aerosol systems studied (C in N_2, C in Ar, C in Ar + H_2O vapor, TiO_2 in Ar and flyash in Ar). Water vapor did cause an effect on both particles (increased wall loss) and ^{220}Rn daughters (developed particulate characteristics). The stability of the carbon aerosol was not affected by the presence of the ^{220}Rn and daughter products. The significance of the experimental findings is to cast doubt on the assumption of rapid irreversible absorption of radioactive ions at the surface of aerosol particles and on the conclusions reached in various areas of aerosol-radioactivity research where the assumption is made. (Disser. Abstr.)

41037 SIXTH INTERNATIONAL CONFERENCE ON CONDENSATION NUCLEI, ALBANY, N. Y. AND UNIVERSITY PARK, PA., MAY 9 THRU 13, 1966. Albany, Atmospheric Sciences Research Center, 1966. 82p. $3.00. (CONF-660556; CONF-660557).

Abstracts of papers given at the conference are presented. The papers primarily concern particles and their effects on droplet nucleation. Subjects also included are radioactive ions, aerosols, filters, ice crystals, and dust and AgI atmospheric effects. 48 abstracts. (J.R.D.)

Mineralogy

41038 PRESENT STATUS AND FUTURE PROSPECTS OF NUCLEAR FUEL RESOURCE. Kamiyama, Teiji (Atomic Fuel Corp., Tokyo). Nenryo Kyokai-Shi, 46: 71-8(Feb. 1967). (In Japanese).

The nuclear power generation, which has almost finished its long preparatory period, is coming near to practical use. In view of the fact that it is expanding, a fundamental policy of steady procurement of uranium resources for the future should established. The current and future demand and supply of uranium fuel in Japan as well as in various countries is described. The necessity for the active exploration and development of domestic uranium resources together with the rapid undertaking of a program of overseas resources procurement are emphasized. (NSA of Japan)

41039 THE SEARCH FOR URANIUM IN AUSTRALIA. Stewart, J. R. (Australian Atomic Energy Commission, Coogee). pp 343-51 of Publications of the Eighth Commonwealth Mining and Metallurgical Congress. Vol. 2. Exploration and Mining

Geology, 1965. Melbourne, Australasian Institute of Mining and Metallurgy, 1966.

Past, present, and projected exploration of U minerals in Australia is reviewed. Extensive data are given on U ore-bearing sites, ore reserves, production, and geology of U mineralization. Total Australian production of U in concentrates to June 30, 1964, was about 8285 short tons of U_3O_8. At the same date, remaining reserves of ore from which U could be extracted and sold economically contained 10,730 short tons of U_3O_8. In addition, other reserves (~2750 t) are available, from which U could be extracted economically if the price rose to $8 to $10 per lb. Further reserves amounting to at least 1500 short tons of contained U_3O_8 are known, but could not be recovered economically at a U_3O_8 price less than $20 per lb under existing technology. As a result of a U search program, occurrences of U-bearing minerals were identified at 400 localities throughout Australia. Of these, about 100 were tested by drilling and/or underground exploration. The cost of finding Australia's economically exploitable deposits of U ore was about 5 shillings per lb of U_3O_8 in ore. Uranium mineralization in South Australia is restricted virtually to rocks of earliest Precambrian (Archaean) age. Only a few minor occurrences are known in rocks of younger geological age. Within the areas of outcrop of Archaean rocks, U mineralization is associated with bodies of sodic granite, which may have been formed by soda metasomatism of pre-existing sediments. The uranium-bearing mineral present in many of the South Australian occurrences is davidite. (BBB)

41040 DETERMINATION OF URANIUM AND THORIUM BY MEANS OF PHOTONUCLEAR METHODS IN SOME YUGOSLAV ROCKS. Pavlovic, B. V.; Petrovic, D. V. Rad. Zavoda Fiz., 5: 51-8(1965). (In Bulgarian).

An examination of U and Th in some rocks by alpha particle tracks in photo-nuclear emulsions, indicated that the results obtained by this method do not always agree with those obtained by means of uranium fluorometric and thorium emanometric methods. These deviations are particularly great when compared with the results in defining U concentrations in travertines. Analysis of the origin of these deviations led to the conclusion that they occur as a consequence of radioactive disequilibrium which exists between some elements of radioactive series, found in the patterns of rocks under examination. The Coppens formula that was used in the calculation of U and Th concentration by means of the photonuclear method is applied only in those cases when these elements are in radioactive equilibrium with their disintegrational products. (auth)

41041 PRESENCE OF URANINITE BOTH IN THE USUAL ACCESSORY MINERAL AND IN THE TWO-MICA URANIFEROUS GRANITES OF LIMOUSIN AND VENDEE. Barbier, Jean; Carrat, Henry G.; Ranchin, Guy (Centre de Recherches Radiogeologiques, Vandoeuvre-Nancy, France). Compt. Rend., Ser. D, 264: 2436-9(May 22, 1967). (In French).

It is shown that in the granites of Limousin and Vendee which contain uraniferous ores, uranium in the trace state is bound to a great degree to the primary automorphic opaque inclusions. Mineralogic and radiogeologic studies permitted the inclusions to be identified as uraninite. These uraninite crystals were easily leached out, which explains their rarity at the surface. (tr-auth)

41042 URANIUM, THORIUM, AND PROTACTINIUM IN A MANGANESE NODULE. Ku, Teh-lung; Broecker, Wallace S. (Columbia Univ., Palisades, N. Y.). Earth Planet. Sci. Lett., 2: 317-20(July 1967).

Isotopic compositions of uranium, thorium and protactinium have been determined in a manganese nodule dredged from the North Pacific Ocean. Both the ^{230}Th and ^{231}Pa activities are found to decay exponentially with depth in the nodule. The corresponding accretion rate of the nodule, averaged over the past several hundred thousands of years, is about 4 mm/10^6 y. The depth distribution of the unsupported ^{234}U activities in the nodule indicate that the $^{234}U/^{238}U$ ratio of the oceanic uranium has undergone a minor change for the last few hundred thousand years. The fluctuation has been no more than ±2% of the present value of 1.15. (auth)

41043 URANIUM AND THORIUM CONTENTS IN ULTRA-BASIC ROCKS. Wakita, H. (Japan Atomic Energy Research Inst., Tokyo); Nagasawa, H.; Uyeda, S.; Kuno, H. Earth Planet. Sci. Lett., 2: 377-81(July 1967).

Neutron activation analysis has been made on U and Th in possible mantle materials, mainly peridotite nodules from continental and oceanic areas. It seems that oceanic peridotite nodules have more uniform contents of U and Th, and Th/U ratio, than continental ones. Average contents of 8 oceanic lherzolites are (2.14 ± 0.26) × 10^{-8} g/g U and (5.48 ± 0.87) × 10^{-8} g/g Th. If the terrestrial ratio is assumed for K/U, the heat production rate of these lherzolites is about 80% of that of chondrites. This value is too small to account for the observed heat flow of the average oceanic upper mantle. (auth)

41044 THE INVESTIGATION AND EXPLOITATION OF SPANISH URANIUM RESOURCES. Martin-Delgado Tamayo, Juan (Junta de Energia Nuclear, Madrid). Energ. Nucl. (Madrid), 11: No. 45, 4-17(Jan.-Feb. 1967). (In Spanish).

Preliminary explorations for uranium ores in Spain are outlined. The prospecting organization is described. The sites of the more detailed explorations (Addujar, Caceres, Cuidad Rodrigo, southwest Spain, Galicia, and Cataluña) are described. The uranium reserves of Spain are evaluated. (J.S.R.)

41045 RADIATION EFFECTS ON FLOTATION OF MINERALS. Plaksin, I. N.; Mal'sheva, N. G.; Starchik, L. P. Dokl. Akad. Nauk SSSR, 175: 663-4(July 21, 1967). (In Russian).

An improved pneumatic flotation chamber of Hillmond-Classen construction was used in the investigation of beryllium, spodumene, ilmenite, hubernite, pyrochlore, and pyrate flotation in a radiation field with radiation source of ^{90}Sr and ^{90}Y of 500 mCi activity (the maximum β radiation E_{max} = 2.27 MeV) and $^{144}Ce + ^{144}Pr$ of ~3 Ci activity (maximum β radiation E_{max} = 3.15 MeV). Flotation with oleinic acid as absorbent-reagent increased the froth product of spodumene 8%, ilmenite 9%, pyrochlore 15%, and reduced the froth yield of zirconium 5%, hubernite 3%, and rutile 5%. The duration of flotation was 30 to 40 min. Flotation directly in radioactive fields increased the yield and extraction of valuable components, increased selectivity of the reagents and reduced reagent consumption. (R.V.J.)

Oceanography

Refer also to abstracts 40992, 40996, 41002, and 41042.

41046 (BNWL-SA-1403) COMPARISON OF TURBULENCE SPECTRA FROM HANFORD, WASHINGTON AND LIBERAL, KANSAS. Elderkin, C. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sept. 5, 1967. Contract AT(45-1)-1830. 13p. (CONF-670931-5). Dep. CFSTI.

From USAEC Meteorological Information Meeting, Chalk River, Ontario, Canada.

Turbulence measurements were made both at Hanford, Washington, on the Atomic Energy Reservation, and at Liberal, Kansas, site of the Air Force Cambridge Research Laboratory micrometeorological field studies. The same instrument was used for measuring the three components of the wind at both sites and the same analog computer equipment and techniques were used for analysis of the data, assuring an optimum basis for comparison of turbulence spectra from the two regions which differ considerably in terrain features and vegetation cover. In spite of the differences in physical characteristics of the two sites, the normalized spectral distributions for each of three components have similar shapes at the two sites, demonstrating occurrence of peaks and approaches to the inertial subrange in comparable ranges of normalized wave number, $nz/\overline{U}$. (auth)

41047 (YALE-2912-13) TRACE ELEMENTS IN NATURAL WATERS. Annual Progress Report, December 1, 1966-November 30, 1967. Turekian, Karl K. (Yale Univ., New Haven, Conn. Dept. of Geology). Aug. 31, 1967. Contract AT(30-1)-2912. 99p. Dep. CFSTI.

Developments are reported for studies on: deep-sea deposition of Ba, Co, and Ag; stream supply of dissolved Ag, Mo, Sb, Se, Cr, Co, Rb, and Cs to the oceans; trace-element composition of suspended material in streams; and deposition of U from the ocean. Preliminary results are given for studies on: the fate of Co, Ni, and Ag in Long Island Sound; Th and U concentrations and isotope ratios in river sediments; and the feasibility of using sponges for trace-element concentration from sea water. (P.C.H.)

41048 ARTIFICIAL RADIOACTIVITY IN THE SEA. Miyake, Y. (Meteorological Research Inst., Tokyo). pp 78-87 of The Seas. Hill, M. N. (ed.). Vol. 2. New York, Interscience Publishers, 1963.

The extent of contamination of the oceans by fission products from nuclear weapon tests and disposal of waste radionuclides is reviewed; data are included on their accumulation by marine organisms. Based on measurements of radioactivity in the Pacific Ocean, the total activity released directly into seawater at nuclear test areas was estimated to be about 3 MCi in 1954. Since no large surface or subsurface tests were made subsequently in the Pacific, the total amount of ^{90}Sr due to the direct injection and immediate fallout up to 1960 would have been roughly 4 to 5 MCi. It was estimated that the contaminated area in the North Pacific from flowout of radioactivity is about 3×10^7 km^2, which is equal to about 20% of the sea surface of the Northern Hemisphere. The average activity in seawater

in the contaminated area would be about 1.5 to 2 μμCi/l, including delayed fallout, assuming the depth of thermocline as 100m. Analytical results on ^{90}Sr in seawater in North Pacific waters from 1957 to 1959 showed 0.7 to 2.3 μμCi/l, these latter values being in good agreement with the above estimations. Studies of enrichment of radioactive substances in marine products have shown considerable amounts of ^{65}Zn, ^{55}Fe, and ^{59}Fe, which are not fission products but neutron-induced radionuclides, in the marine organisms collected in June 1954, in the North Pacific. Since then, ^{54}Mn, ^{57}Mn, ^{57}Co, ^{58}Co, and ^{60}Co have been found in the internal organs of fish caught in the western region of the North Pacific. Observations carried out in nuclear test areas in 1954 and 1956 indicated that the gross activity was from 1000 to 10,000 times more concentrated in zooplankton than in water when compared on a weight basis. The results of the calculation of diffusion coefficients for radioactivity distribution in the North Pacific revealed values between 0.8 and 1.4×10^3 where the lateral distance from the center of diffusion was from 890 km to 3200 km. Problem results from disposal of radioactive waste in the ocean are discussed. (BBB)

41049 NATURAL RADIOACTIVITY OF MARINE SEDIMENTS ALONG THE ESTEREL COASTS. Bellaiche, Gilbert; Pautot, Guy; Anguenot, Francois; Courtois, Guy (Laboratoire de Geodynamique sours-marine, Villefranche-sur-Mer, France. CEA, Saclay, France). Compt. Rend., Ser. D., 264: 2545-8(May 29, 1967). (In French).

The radioactivity of the coastal marine sediments presents well-defined characteristics, which can be explained by the action of different hydro-dynamic agents such as sea swells and some currents on the sedimentary particles of different radioactivity. (trauth)

41050 RADIUM CONTENT IN PLANKTON AND SEA WATER IN THE BAHAMAS. Szabo, B. J. (Univ. of Miami, Fla.). Geochim. Cosmochim. Acta, 31: 1321-31(Aug. 1967).

The distribution of radium-226 in the ocean and in marine organisms is surveyed. Data on the distribution of radium in the Bahamas region are presented; average radium content in surface water is found to be 4.5×10^{-14} g/l. Six mixed plankton samples were analyzed for the alkaline earth elements. The average radium content in plankton was determined to be 2.2×10^{-13} g/g_{ash}. Discrimination factors, normalized to calcium ($DF^{Ca}_{Ca} = 1$), are calculated. Both radium and barium are found to be preferred by the plankton ($DF^{Ba}_{Ca} = 19$ and $DF^{Ba}_{Ca} = 18$), there is little preference for strontium ($DF^{Sr}_{Ca} = 1.2$), and magnesium is not taken up preferentially ($DF^{Mg}_{Ca} = 0.10$). The extent of radium removal by the plankton populations is calculated to be in the same order of magnitude as the natural radioactive decay of radium. (auth) (UK)

Seismology

41051 (AD-647554) RESEARCH ON THE CENTRAL CALIFORNIAN LARGE-SCALE SEISMIC ARRAY. Semiannual Technical Summary Report, June-December 1966. Report No. 1506-11. Lomnitz, Cinna (California Univ., Berkeley. Seismographic Station). Dec. 1966. Contract AF49(638)-1506. 53p. CFSTI.

Research on the Central California Large-Scale Seismic Array is described. The objectives of the study are as follows: Maintain and operate the telemetered network of stations in the seismically active Coast Range; Conduct research on the seismic data recorded from this network. This research should include the following: focal mechanism and aftershock characteristics of small earthquakes, propagation of S waves across the network, P-wave coherence from teleseisms, improved travel-time curves. (auth) (TAB)

41052 (AD-649264) STATION CORRECTIONS AT LASA. Scientific Report, November 1, 1965-October 31, 1967. Fairborn, John W. (Massachusetts Inst. of Tech., Cambridge. Dept. of Geology and Geophysics). July 1, 1966. Contract AF49(638)-1632. 26p. CFSTI.

Two types of crustal and/or upper mantle lateral inhomogeneities are postulated; they are dipping layers, which have different seismic velocities, and an upper mantle-crustal model having a linear velocity gradient in the horizontal direction. The P-wave travel time deviations as a function of azimuth angle to the earthquake epicenter are calculated for each model and compared, on the basis of magnitude, with the azimuthally dependent part of station corrections observed at LASA and TESO. In the case of LASA, dipping layers cannot account for the observed station corrections. Horizontal velocity gradients, on the other hand, may account for the observations if the thickness over which the gradient extends is sufficiently large—probably greater than the crustal thickness. (auth) (TAB)

41053 (PNE-1106) STRUCTURES INSTRUMENTATION. Project Pre-GONDOLA I. Ballard, Robert F. Jr. (Army Engineer Waterways Experiment Station, Vicksburg, Miss.). May 1967. 72p. Dep. CFSTI.

Three microseismic stations were operated by the U. S. Army Engineer Waterways Experiment Station (WES) during the Pre-GONDOLA I cratering calibration series at Fort Peck, Montana. The seismic stations, located in the center of the dam, the Gate Control Structure No. 3, and on the spillway, were monitored for the purpose of determining structure response resulting from the 20-ton charges detonated approximately 12 miles from the dam. Particle velocity data were recorded simultaneously on oscillographs and magnetic tape. Oscillograms were analyzed for maximum transient zero to peak particle velocities, and the tape was subjected to linear and power spectral density analysis from 0.5 to 20 Hz over a period of 160 sec. The results of the study indicate that the amplitudes recorded during this test series exceeded the motions recorded during the 1000-lb calibration series by approximately 30 times at all stations. This report presents a documentation of test data. (auth)

41054 P-WAVE VELOCITIES IN THE MANTLE BELOW 700 KM. Chinnery, Michael A. (Brown Univ., Providence); Toksoz, M. Nafi. Bull. Seismol. Soc. Amer., 57: 199-226(Apr. 1967).

Measurements of the slope of the travel-time curve were made on 167 seismic events in the distance range 27° to 90° along on azimuth of 300° to 320° from the LASA array in Montana. A first-order correction of +0.05 sec/degree was applied to the raw data to make them consistent with the travel-time residuals observed from the Longshot nuclear test in the Aleutian Islands. The agreement between these 2 sets of data is sufficiently good that other station corrections at the array are assumed to be negligible. The resulting graph of $dT/d\Delta$ against Δ is shown to be consistent with other travel-time and amplitude observations. Using an assumed crust and upper mantle structure, a velocity depth model for the mantle was found which agrees, within the scatter of the data, with both the $dT/D\Delta$ observations and the Longshot nuclear test residuals. This model showed 3 anomalous regions within the mantle, at depths of about 800, 1300, and 2000 Km, where the velocity changes very slowly with depth. In each case the possibility that the velocity decreases with depth exists, but was not proven by the present data. (BBB)

ENGINEERING

Nuclear Explosions

Refer also to abstracts 41035, 41053, and 41182–41184.

41055 (AD–645599) POSTATTACK SANITATION, WASTE DISPOSAL, PEST AND VECTOR CONTROL AND THE EFFECTS OF FALLOUT IN WASTE WATER AND SEWER SYSTEMS. Final Report, Phase 2. Harmon, Judson A.; Leach, John M. (Engineering-Science, Inc., Arcadia, Calif.). Jan. 1967. Contract N228(62479)68147. 99p. (USNRDL–TRC–79). CFSTI.

Information is presented on the magnitude, character, and timing of postattack sanitation operations for the San Jose Metropolitan Area of California. The effectiveness of these overall operations on maintaining disease incidence at levels which will not be detrimental to postattack recovery is assessed. Information is presented on the sedimentary effects of fallout washed into drainage systems including: a method to determine the effects; and the sections of the systems which are most likely to experience sediment build-up. The results of the analysis of the postattack sanitation operations in the Study Area indicate approximately 60 percent of the waste collection vehicles will be damaged, but due to increased use of the surviving vehicles and the postattack reduction of household refuse production, no detrimental effect on the overall postattack recovery of the area is expected. The study of fallout transport in drainage systems indicates that sediment buildup will occur when the flow rate per unit of width is decreased, as in the case of water exiting from a catch basin connector pipe into a main line. (TAB)

41056 (AD–645663) REPRESENTATION OF A NONSPHERICAL UNDERWATER EXPLOSION BUBBLE BY A VORTEX SHEET AND SOURCE SHEET. Bell, Larry W. (Naval Ordnance Lab., White Oak, Md.). Nov. 22, 1966. 77p. (NOLTR–66–211). CFSTI.

The equations for the velocity potential, partial time derivative of the velocity potential, tangential velocity, and normal velocity for a source sheet and vortex sheet representation of the nonspherical underwater explosion bubble were derived and programmed for the IBM 7090 computer. These equations were tested for the known case of a spherical underwater explosion bubble and the results were sufficiently accurate for practical application. The conclusion is that the nonspherical underwater explosion bubble can be represented by a source sheet and vortex sheet. This representation will not interfere with the jet rising into the interior of the bubble, as is the case of the earlier models consisting of a single point source and a single dipole located on the axis of symmetry. (auth) (TAB)

41057 (PNE–900F(Rev.1)) GROUND MOTION. Project PALANQUIN. Rohrer, R.; Terhune, R. W. (California Univ., Livermore. Lawrence Radiation Lab.). Aug. 1967. Contract W-7405-eng-48. 46p. Dep. CFSTI.

Data concerning the surface motion as a function of time for the Palanquin nuclear cratering event are presented. A description of the experimentation and the general surface motion is given. The data for the surface motion time history are obtained from reading and analyzing, by means of digital computer, the film from high-speed photography of surface motion. Graphs of the vertical and horizontal displacement and vertical velocity of individual surface motion targets vs time are presented. (auth)

41058 (UCRL–70443) NUMERICAL SIMULATIONS OF SHOCK TUBES. Crowley, Barbara K. (California Univ., Livermore. Lawrence Radiation Lab.). July 15, 1967. Contract W-7405-eng-48. 18p. (CONF-670712–4). Dep. CFSTI.

From Conference on Military Application of Blast Simulators, Alberta, Canada.

The numerical simulation of shock tube flow is considered with the PUFL finite difference calculation which is used to integrate the time-dependent partial differential conservation equations. The results of some PUFL calculations with and without frictional terms are compared with experimental data from the BRL shock tube. The results indicate that the time-dependent solutions are of prime importance in determining the decay of the pressure pulse as it progresses down the tube. They also indicate that significantly better agreement with experimental data is obtained by considering the effects of friction. The agreement of calculational results and experimental data for the width and height of the pressure pulse as it progresses down the tube indicates that the numerical simulation of shock tubes is feasible. (auth)

41059 (USNRDL–TR–67–70) SENSITIVITY ANALYSIS OF THE RADIAL DISTRIBUTION MODEL. SENSITIVITY TO CARRIER MATERIAL, YIELD AND TYPE OF FISSION. Cassidy, S. H.; Crocker, G. R. (Naval Radiological Defense Lab., San Francisco, Calif.). May 22, 1967. Contract AT(49-7)-1963. 86p. Dep. CFSTI.

A method was developed for calculating the distribution of fission-product nuclides among fallout particles as a function of size. Calculations from this Particle Activity Module of radionuclide fractionation in land-surface nuclear bursts have been tested for sensitivity to input parameter variations such as variations in weapon yield, variations in type of fission, and difference in solidification temperature of the carrier material (silicate soil or coral). During the calculations a fourth input parameter, particle-size distribution, was unchanged. The calculations show the model to be relatively insensitive to variation in weapon yield and type of fission. The calculations at a solidification temperature appropriate to coral (2887°K) indicated that particles smaller than 47 microns in dia contribute about 70% of the total exposure rate, while the calculations at the silicate soil solidification temperature (1673°K) indicate about 60%. The proportions of the 1-hr exposure-rate contributed by volatile, mixed, and refractory fission-product chains are considerably different for the two solidification temperatures. The temperature sensitivity of the model should be investigated in more detail, since there is reason to believe that changes in fractionation behavior which are not apparent at 1 hour after burst might be important at later times. (auth)

Facilities and Equipment

Refer also to abstracts 41103, 41104, 41109, 41116, 41149, 41153, 41157–41160, 41959, and 42857.

41060 (AD–647350) INSTALLATION AND TESTING OF AN AUTOMATIC REMOTE RADIOLOGICAL MONITORING SYSTEM. Final Report. Harries, William S.; Metzler, Robert E.; Lawson, Melvin E. Jr. (Gautney and Jones Communications, Inc., Washington, D. C.). July 1966. Contract OCD-PS-64-262. 127p. CFSTI.

An Automatic Remote Radiological Monitoring System which was developed was installed in a community and tested for operational characteristics. The system as delivered was capable of being operated via landline telemetry links but considerable engineering effort was required to effect an interface with a VHF radio link. Extensive modification of both the base station and remote station transceivers as well as the monitoring equipment was performed. When the radio telemetry problems had been solved, the system was deployed in Montgomery County, Maryland, which comprises an area of approximately five hundred square miles. The units were installed on County School properties distributed throughout the County, and the deployment pattern includes path lengths ranging from three and one half to fifteen and one half miles over rolling terrain. Telemetry modes successfully employed in the installation include two vhf single frequency radio links, six standard leased landline links, one combination leased landline — Bell System Audio Carrier link and one combination leased landline — duplex microwave link. The system is now operational and is currently being evaluated, under a separate contract, for effectiveness in its present form and for improvements in reliability and operability that may be incorporated in future systems. (auth) (TAB)

41061 (DP–MS–67–68) SRL METEOROLOGY SYSTEM. Cooper, R. E.; Rusche, B. C. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Sept. 1967. Contract AT(07-2)-1. 11p. (CONF-670931–2). Dep. CFSTI.

From USAEC Meteorological Information Meeting, Chalk River, Ontario, Canada.

The facilities used in the Savannah River Laboratory Meteorological Program and operational experience with the program are described. The primary facility being used is a TV tower that is instrumented to a height of 1200 ft. Another tower has instruments to 110 ft. The system, in service for about two years, provides wind speed, wind direction, standard deviation of wind direction, and temperature data once every 3 to 5 min at each tower. Output data are punched on paper tape in a form suitable for computer processing. The instruments have performed satisfactorily since correction of the initial problems detected during checkout of the equipment. Sensors mounted on the 1200-ft tower are serviced every 3 months unless major damage occurs. The major hazard has been the melting and falling of ice during warm periods of the winter months. No problems due to pickup have been encountered at the TV tower. Availability of the equipment has been

better than 90% since February 1966. The system is expected to continue in service for about another year. (auth)

41062 (ORNL-TM-1900) HOT PRESSES FOR GLOVE BOX AND MANIPULATOR CELL USE. Quinby, T. C.; Pierce, E. E.; McHenry, R. E. (Oak Ridge National Lab., Tenn.). Aug. 1967. Contract W-7405-eng-26. 14p. Dep. CFSTI.

Two hot presses were designed to fabricate dimensionally accurate compacts: a miniature press for research and development operations in glove boxes and a larger press for production applications in manipulator cells. The miniature hot press is designed to withstand very rapid heating and cooling cycles as well as rapid pumpdown or purging. Self-alignment is incorporated in the pressing column, and packed insulation in the furnace is eliminated to achieve compactness and simplicity. The miniature press can be readily disassembled and reassembled in a glove box through the access ports. Although it was designed primarily for use with radioactive materials, it is also useful for general development work where easy operation, small sample size, and rapid heating-cooling cycles are desired. Samples in the range of $\frac{1}{4}$ to $\frac{1}{2}$ in. in dia can be compacted in the miniature press. The production hot press was designed to fabricate sources in the range of $\frac{3}{4}$ to 3 in. in dia. The production press has a self-aligning pressing column and an induction-heated furnace. Both presses have been operated at 1800°C. Graphite dies or graphite dies lined with refractory metals or alumina have been used in all applications. (auth)

41063 (ORNL-TM-1901) CONCEPTUAL DESIGN OF A 250-MGD VERTICAL TUBE EVAPORATOR FOR SEAWATER DESALINATION. PHASE I. SELECTION OF FLOWSHEET, LAYOUT AND DESIGN CRITERIA. Hise, E. C. (comp.) (Oak Ridge National Lab., Tenn.). Sept. 1967. Contract W-7405-eng-26. 131p. Dep. CFSTI.

The conceptual design of a 250-M gal/day vertical-tube evaporator is described. The preliminary engineering steps leading to selection of the flowsheet, plant layout, and other basic criteria are described. Design and analytical comparative evaluations led in some cases to clear cut selections for the final plant design and in other cases indicated that there is a considerable latitude for a designer to exercise engineering judgement. The most striking of the comparisons was that of a plant with conventional smooth tubes in the vertical evaporator to one with high-performance vertical tubes of the doubly fluted type developed by General Electric. Fluting increases the heat transfer coefficient 200 to 300% while increasing the tubing cost only 5 to 10%. The comparison of the multistage-per-effect feed heating with single-stage-per-effect also favored the multistage feed heating. The rectilinear plant design was marginally cheaper than the concentric ring or vertical designs and was best suited to the multistage feed heating process. The parametric studies used to examine a range of variables such as number of effects, concentration ratio, feed heater performance ratio, and terminal temperatures indicated that there is a fairly large region in which changes of capital cost are compensated by changes in operating cost in such a way that the cost of water is virtually unaffected. Some of the final design values were chosen for reasons other than economic optimum and some were chosen arbitrarily. Experimental measurements supported the validity of the design heat transfer coefficients and of the design steam pressure loss through the bundles of three-inch fluted tubes. Cost estimates by the staff and by appropriate manufacturers were used to establish materials and fabrication costs. Heat costs and plant costs for the chosen design were balanced to obtain a plant performance ratio that would yield near minimum cost water. The plant selected for the final conceptual design is a 15-effect, falling film, doubly fluted-tube evaporator with a 50-stage flash feed heater-product cooler. The overall performance ratio is 13. The four-train shell structure is rectilinear having the evaporator integrally housed and directly above the feed heater-product cooler. The preliminary cost estimates of this design indicate a capital cost of about $0.30 per daily gal. or a water cost of about $0.12 per 1000 gal. (auth)

41064 (SC-DC-67-2050) UNIFIED CLEANING FACILITY IN A CLASS 100 CLEAN ROOM. Kenagy, J. A. (Sandia Corp., Albuquerque, N. Mex.). Sept. 1967. Contract AT(29-1)-789. 23p. (CONF-670919-2). Dep. CFSTI.

From AEC/NSA Contamination Control Symposium, Albuquerque, N. Mex.

A down draft clean room is described which has been equipped for cleaning and potting in a development shop which provides support to various laboratory operations. The clean room was designed and built to comply with Federal Standard #209 for a Class 100 room. Mechanical and electrical components are cleaned and potted in this clean room and the necessary auxiliary equipment has been installed in the room for processing a variety of plastics systems. Special care has been given to handling toxic and flammable materials. An ultrasonic cleaner is used for rough cleaning and a final rinse station is used for final cleaning. An indium surface cleanliness tester is used for checking components prior to potting. Semiautomatic vacuum chambers deaerate resin systems during the processing operations. Curing ovens and an autoclave are also used for post cures on various plastics systems. Slides are used to show the main features of the clean room and to show the auxiliary equipment. (auth)

41065 (TID-4100(Suppl.40)) ENGINEERING MATERIALS LIST. Supplement 40. Kelly, Robert C. (ed.) (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). Sept. 1967. 82p. DTIE Free.

Thirty-nine packages of engineering materials on computers, electronic equipment, equipment used with accelerators, hot cells, instruments, laboratory equipment, radiation detectors, and reactor fuel elements are announced in this supplement for inclusion in TID-4100. (F.S.)

41066 APPLICATION OF A RADIATION RELAY TO AN INTERLOCK SYSTEM. Minakoshi, Shin (Kobe Industries Corp., Japan). Otomeshon, 11: 75-8(Oct. 1966). (In Japanese).

A radiation relay is described which is employed in industry for the same purpose as the light ray relay. The main advantage to the radiation relay is its high sensitivity which is not affected by smoke, dust, and high temperatures. An example of this is seen in the interlock system, using a radiation relay, for pushing the produced coke out of a coke oven. The interlock system, employing a radiation relay, consists of a radiation source, radiation detector, and radiation amplification and indication systems. In the detection section, two scintillation probes and amplifiers are installed, each series, containing a probe and amplifier, functions as a separate system; thus, forming a selfchecking system. The radiation from the source passes through the space in the upper part of the coke oven, reaching the detector. The interlock system works as follows: if the radiation, i.e., gamma rays do not reach the detector, the device for pushing out the coke cannot be operated. This will occur under the following conditions: the coke guide-truck and the pushing-out device are not on a line, the oven lids are not removed, and preparation of the coke guide is not complete and the gamma-ray absorbing plate is not opened. (NSA of Japan)

41067 EFFICIENCY OF FILTERS FOR RADIOACTIVE AEROSOL. Kimura, Kikuzi (Inst. Sci. Labour, Soshigaya II, Setagaya-ku, Tokyo). Rodo Kagaku, 42: 696-702(Oct, 1966).

Most kinds of dust filters that are usually highly efficient for ordinary dust particles showed generally low efficiency when tested with radioactive solid aerosols of thoron daughters from thorium nitrate, apparently because of the small particle size of the radioactive aerosol. Glass fiber filters and asbestos-cellulose-glass fiber filters, however, were over 99% efficient in measuring the radioactive aerosol. (Pub. Health Eng. Abstr.)

41068 MANUFACTURE OF END CLOSURES FOR LARGE PRESSURE VESSELS. Mosny, M. (VUZ, Bratislava). Tech. Pr., No. 8, 639-40(1966). (In Czech).

A method was developed for manufacturing end closures for large pressure vessels used in chemical, power, and nuclear installations. The specifications for these end closures cannot be met by cast parts but only by wrought. In the method, carbon-steel (about 0.20% C) ingots up to 50 tons are rolled and forged into curved 200 to 300 mm thick segments for the spherical parts and flat 660-mm-thick segments for the flanges. Flange and hemisphere are electroslag welded and the flange is welded to the hemisphere. This method was used in building the first Czechoslovakian nuclear reactor. (ATD)

41069 3-KILOWATT RECUPERATED CLOSED BRAYTON-CYCLE ELECTRICAL POWER SYSTEM. McCormick, J. E. (AiResearch Mfg. Co. of Arizona, Phoenix); Redding, Tony E. pp 1-7 of Advances in Energy Conversion Engineering. New York, American Society of Mechanical Engineers, 1967.

From 2nd Intersociety Energy Conversion Engineering Conference, Miami Beach, Fla., Aug. 13-17, 1967. See CONF-670806.

A 3-kilowatt closed, recuperated Brayton-cycle power-conversion system is being evaluated by NASA. The principal objectives of the test program are to evaluate overall system performance and design-point characteristics, familiarize personnel with system control and operation methods, and determine system flexibility by operating the system at a number of off-design conditions and over a range of output power levels. The background of this program and the experimental equipment and test facility are described. Also included is a discussion of the applications visualized for a dynamic power system of this type and the various heat sources with which it could be mated. (auth)

41070 AN INVESTIGATION OF THE EFFECTS OF ELECTROMAGNETIC FORCES ON THE ROTOR-DYNAMIC PERFORMANCE OF A 15 KVA GAS-BEARING BRAYTON CYCLE TURBOALTERNATOR. Curwen, P. W. (Mechanical Tech. Inc., Latham, N. Y.); Frost, A.; Tryon, H. B. pp 9-31 of Advances in Energy Conversion Engineering. New York, American Society of Mechanical Engineers, 1967.

From 2nd Intersociety Energy Conversion Engineering Conference, Miami Beach, Fla., Aug. 13–17, 1967. See CONF-670806.

The stability and dynamic response of the rotor-bearing system for a 15 kVA gas-bearing turboalternator has been studied both analytically and experimentally. Test data were obtained from a full-scale rotor-bearing system simulator capable of operating under the same electrical power and bearing ambient conditions as will be experienced by the prototype turboalternator. Analytical and test data are presented for both balanced and unbalanced operation of the 3-phase alternator with the alternator rotor eccentric to the stator. Various load conditions were investigated, including single- and 3-phase short circuits at rated load. The test results qualitatively confirm the analytical results in the sense that dynamic effects of alternator electromagnetic forces are small over the anticipated range of rotor eccentricities and bearing operating conditions. No evidence of rotor-bearing system instability was detected. Performance of the gas bearings was excellent, even under conditions of an unintentional turbine labyrinth rub. (auth)

41071 DISSOCIATING GAS AS WORKING FLUID FOR SPACE POWER PLANT. Cheung, H. (Univ. of California, Livermore). pp 33-6 of Advances in Energy Conversion Engineering. New York, American Society of Mechanical Engineers, 1967.

From 2nd Intersociety Energy Conversion Engineering Conference, Miami Beach, Fla., Aug. 13–17, 1967. See CONF-670806.

An inert gas Brayton cycle requires a larger radiator than does a Rankine cycle operating at the same temperature. For power plants in the megawatt range operating between 5 and 500 psia and under 4000°R, replacing the inert gas with a dissociating gas would reduce the Brayton cycle radiator area by a factor of four. Nevertheless, the Brayton cycle must still operate at somewhat higher temperatures to be competitive with the Rankine cycle when radiator area is the primary consideration. (auth)

41072 SYSTEMS ANALYSIS OF RADIOISOTOPE THERMOELECTRIC GENERATORS. King, Matthew; Simms, Richard (TRW Systems, Redondo Beach, Calif.). pp 189-96 of Advances in Energy Conversion Engineering. New York, American Society of Mechanical Engineers, 1967.

From 2nd Intersociety Energy Conversion Engineering Conference, Miami Beach, Fla., Aug. 13–17, 1967. See CONF-670806.

Discussions are presented of a systems optimization methodology that has been developed to analyze radioisotope thermoelectric generators (RTG's) for spacecraft applications. A computer program, GENSOP, has been utilized to perform the numerical computations necessary to optimize principal design variables. At present, models for the thermoelectric converter and heat source have been tested with the program. Optimum generator designs have been computed by the code for up to seven independent variables. (auth)

41073 ELECTROGASDYNAMIC POWER GENERATION. Cowan, P. L.; Gunzler, T.; Kulka, R.; Gourdine, M. C. (Gourdine Systems, Inc., Livingston, N. J.). pp 435-55 of Advances in Energy Conversion Engineering. New York, American Society of Mechanical Engineers, 1967.

From 2nd Intersociety Energy Conversion Engineering Conference, Miami Beach, Fla., Aug. 13–17, 1967. See CONF-670806.

The approach being followed in the development of large scale power generation using coal as a primary energy source is outlined. Emphasis is placed on recent theoretical progress with reference to experimental results as required. A proposed configuration of a 500 MW Brayton-cycle plant is presented. (auth)

41074 LARGE HIGH PRESSURE APPARATUS FOR CHEMISTRY, PETROCHEMISTRY, AND NUCLEAR TECHNOLOGY. Maier, A. F. (Rheinstahl Huettenwerke A.G., Hattingen, Ger.). Ind. Chim. Belge, 32: 19-31(1967). (In French).

New methods for producing large capacity high pressure apparatus are discussed in relation to nuclear industry as well as chemistry and petrochemistry. Standard methods of reactor construction are reviewed: the BASF-Schierenbeck process; the Struthers-Wells method; and the A. O. Smith-Ruhrstahl technique. A new process is described for producing the solid-wall vessel, used in nuclear reactors where temperatures of 420 to 480°C are required. Pressures up to 280 atm can be attained. Individual rings are fabricated from steel containing 2¼ to 3¼% Cr and 1.0% Mo. For certain reactors, 20 NiCrMo 36 steel is used, limiting the carbon content to 0.23% maximum. For thinner walls, about 80 mm, the limit of elasticity is ~40 kip/mm^2. For a thickness of 120 mm it is only 35 kip/mm^2. For walls thicker than 180 mm, Ni content must be increased 2.70 to 3.9%, Cr from 1.5 to 2.0%, and Mo is 0.4 to 0.6%. Lining of nuclear reactor interiors with a corrosion-resistant layer is described. It is shown how electric welding can be performed with a linear accelerator which produces electrons on a 2.5-m trajectory so as to obtain a nominal energy of 12 MeV and has a power of 2000 W. The importance of latest methods of welding parts rather than the classical method of the forging of a single unit is stressed. (BBB)

41075 CENTERS DEALING WITH INFORMATION ON HEAT AND ENERGY PROCESSES. J. Inst. Fuel, 40: 359-73(Aug. 1967).

Organizations in a number of countries possessing information facilities in the fuel and energy field (including nuclear) are listed in tabular form. The list was compiled by OECD, Paris. (UK)

41076 AN IMPROVEMENT OF THE CONTINUOUS-IONIZATION METHOD FOR LINEARITY AT LOW GAS VELOCITIES. Hribar, M. (Univ. of Ljubljana, Yugoslavia. Inst. Josef Stefan, Ljubljana, Yugoslavia). Int. J. Appl. Radiat. Isotop., 18: 631-8(Sept. 1967).

A modified continuous-ionization method for gas flow-rate measurement is described. It is shown that an extended radioactive source, located in the pipe immediately upstream of the collecting electrode, gives a linear collector current vs. velocity response for small gas velocities. Linearity within 1% can be achieved up to a definite velocity, and extension of the linearity to higher velocities is possible by adding a second source upstream of the first. The effects of the gas composition, pressure and temperature are discussed. It is shown that transients exist in the collector current when the step changes in velocity are applied outside the linear range. (auth)

41077 PRESTRESSING WEAKENED BY IRRADIATION. Perkins, R. F. (Atomic Power Constructions Ltd., London). Engineering, 204: 338-9(Sept. 1, 1967).

The protective requirements for prestressing systems of concrete reactor pressure vessels are discussed with particular reference to the problems of corrosion, stress corrosion, and hydrogen embrittlement. Tables are presented showing the effects of radiation exposure on materials considered for corrosion protection, and the results of exposure tests using them. For the Dungeness 'B' reactor, in which the dose will be about 6.4×10^8 rads per year, a duplex phosphate/grease protective system was used for the cables. (UK)

41078 DESIGN PROBLEMS OF NUCLEAR STEAM TURBINES. Kumeno, Kozo; Hisano, Katsukuni (Hitachi Ltd., Tokyo). Hitachi Hyoron, 48: No. 6, 76-82(June 1966). (In Japanese).

Since the steam turbine for nuclear power generation requires low steam-pressure and temperature, the problems of wet corrosion and its elimination arises. Due to the need of a low-speed turbine, an investigation was made on the suitable types of turbines. Because of the large blade length, it was necessary to use a steam separator or a reheater for anti-corrosion. The steam separators of Hitachi and GE have unique drain channels, and their efficiency is reduced when the relation between the slit of the separator inlet and the orifice is not adequately calculated. By the use of an interim stopper valve, the entrance of steam is prevented, and the motive blade length can be reduced. The ratio (7000–10000 lbs/hr/ft^2) of the end annulus area to the low-pressure exhaust fluid is the most economic with the exhaust vacuum of 722 mm Hg. If the exhaust vacuum is not 722 mm Hg, the above value is inversely proportional to the specific steam volume. There are two methods for corrosion control: the stelite silver soldering method with the problem of change in the composition of the mother metal; and the surface hardening method, with either flame or high frequency hardening. (NSA of Japan)

41079 DESIGN AND OPERATION OF POST-IRRADIATION EXAMINATION FACILITIES. PART I. ANALYSIS OF JHL-1 FOUR YEAR OPERATION EXPERIENCE. Murakami, Masatoshi (Japan Atomic Energy Research Inst., Tokyo). Nucl. Eng. Design, 5: 433-42(July 1967).

The Hot Laboratory of the Japan Atomic Energy Research Institute consists of two parts: JHL-1 and JHL-2. The former is

a row of multi-purpose caves, and the latter consists of single-purpose caves. The latter's design was based on the JHL-1's operation data. The results of analysis of the JHL-1's 4 years of operation are reported. This evaluation of accumulated operational experience may serve as a guide for the rational planning and design development of similar hot laboratory installations. (auth)

41080 CRITERIA OF APPROXIMATE DIMENSIONAL SIMILARITY FOR A PLASMOTRON ARC WITH A SELF-ESTABLISHED LENGTH AND WITH VORTEX GAS STABILIZATION. Smolyakov, V. Ya. Zh. Prikl. Mekh. Tekh. Fiz., No. 1, 151-7 (Jan.-Feb. 1967). (In Russian).

Dimensionless criteria were found for the dimensionless fall in potential on an arc column. It was found that: $U/U_i = \phi(K_1, K_2, K_3)$ where $K_3 = \gamma$, $K_2 = R_2/R_a$ and $K_1 = A_0 p R_a G c_p t_0 / I U_i$. Here γ is second Townsend ionization coefficient; R_2 is the radius of the outer coaxial cylinder of the plasmatron; R_a is the radius of the arc; $A = 1/\lambda p = A_0 T_0/T$; p is the gas pressure; λ is the mean free path of the electron; G is the mass gas flow; c_p is the average heat capacity at constant pressure; T is the gas temperature at breakdown, and I is the arc current. The terms K_1 and K_2 can be multiplied to give a new dimensionless criterion $K_4 = A_0 p R_2 G c_p T_0 / I U_i$. If K_4 is kept constant, the fall in potential on the arc should also remain unchanged. A plot of lg U as a function of i = I/GDp gave a straight line under conditions where the mass gas flow was varied by a factor of 60 (from 0.5 to 30 g/sec), the current by a factor of 25 (from 10 to 250 amps), and the electrode diameter by a factor of 4 (from 0.5 to 2 cm). The data were found to fit the following equation: $U = C(GDp/I)^{\alpha}$. Here C and α respectively have values of 1140 and 0.41 for unidirectional arc with direct polarity, 1230 and 0.33 for a unidirectional arc with reverse polarity, 1660 and 0.33 for two directional arc flow with direct or reverse polarity. (TTT)

41081 CHARACTERISTICS OF A PLASMOTRON WITH AN INTERELECTRODE INSERT. Dautov, G. Yu.; Dudnikov, Yu. S.; Zhukov, M. F.; Mustafin, G. M.; Sazonov, M. I. Zh. Prikl. Mekh. Tekh. Fiz., No. 1, 172-6(Jan.-Feb. 1967). (In Russian).

The experimental unit had water-cooled copper cathode, an anode, and separately insulated sections each having a length of 2 cm. The number of sections n was varied from five to eight. The interelectrode distance a was varied from 10.5 to 16.9 cm, and the length of the arc chamber was varied from 15.5 to 22 cm. Part of the gas flow was distributed through 1 mm gaps in the sections along the arc chamber. Voltage and arc current readings were taken. At I = 150 amps, n = 8, and mass gas flow G = 8 g/sec, the arc voltage was increased by 40% in comparison with a single-chamber plasmatron due to the modified design. The pulsations in voltage and arc brightness in the modified plasmatron were significantly lower than in the usual single-chamber plasmatron. At large currents the thermal efficiency of the modified plasmatron exceeded that of the single-chamber plasmatron. Higher gas temperatures were obtained in the modified unit at the same current flow. (TTT)

41082 EFFECT OF CONVECTIVE HEAT EXCHANGE OF PLASMOTRON CHARACTERISTICS. Kutateladze, S. S.; Rebrov, A. K.; Yarygin, V. N. Zh. Prikl. Mekh. Tekh. Fiz., No. 1, 157-60(Jan.-Feb. 1967). (In Russian).

At a pressure $<10^3$ mm Hg std and a temperature <10,000°K, the efficiency η is determined by the convective heat exchange: $\eta = G\Delta h/IU = 1 - Q/IU$. For a single-chamber plasmatron $Q = \alpha(h_2 - h_w)\pi dl$. Here h_2 is the average mass enthalpy of the gas at the plasmatron exit; α is the average heat exchange coefficient over the surface πdl. For ordinary conditions $h_w \ll h$ and $h_1 \ll h_2$, and it follows: $(1-\eta)/\eta = 4(l/d)\,S$, where $S = \alpha/g$ is the Stenton number, and g is the mass flow rate. For laminar flow, $S \sim Re^{-0.5} Pr^{-0.67}$, where Re is the Reynolds number and Pr is the Prandtl number. Then, it is assumed that: $[(1-\eta)/\eta]\, Re^{0.5} Pr^{0.67} = f(l/d, \epsilon)$, where ϵ is a factor taking into account the arc breakdown. Experimental plasmatron measurements were made on the thermal fluxes to the electrodes, the average mass gas temperature at the exit and the efficiency. It was found that $(1-\eta)/\eta \sim Re^{-0.5}$, which confirmed the presence of laminar flow at the channel wall. An expression is given for the volt–ampere characteristics of the plasmatron. (TTT)

41083 PULSATIONS IN A PLASMOTRON WITH A SELF-STABILIZED ARC. An'shakov, A. S.; Dautov, G. Yu.; Mustafin, G. M.; Petrov, A. P. Zh. Prikl. Mekh. Tekh. Fiz., No. 1, 161-6(Jan.-Feb. 1967). (In Russian).

The experimental unit was a single-chamber plasmatron having an anode consisting of 16 sections separated from each other by a thickness of 7 mm. The minimum gap between the cathode and the first anode section was 1.5 to 2.0 mm. Most of the experiments on the plasmatron with the sectioned anode were carried out with an arc current I = 70 amps, a mass flow rate of the gas G = 6 g/sec, and the internal anode diameter d = 1 cm. The arc voltage was 440 volts. The distributions of voltage, current and brightness in the arc were determined, and oscillograms of these quantities were obtained. The simultaneous existence of a number of anode spots was shown by various methods. It is shown that the magnetic field of the arc itself has an effect on its behavior. (TTT)

41084 DISTRIBUTION OF ELECTRIC FIELD STRENGTH ALONG THE LENGTH OF A LONGITUDINAL ARC IN A CONSTANT-CURRENT PLASMOTRON. Vasil'kovskaya, A. S.; Kolonina, L. I.; Lebedev, A. D.; Smolyakov, V. Ya. Zh. Prikl. Mekh. Tekh. Fiz., No. 1, 166-71(Jan.-Feb. 1967). (In Russian).

The experimental unit contained copper electrodes with six special 1.6 mm holes drilled in the outer electrode for probe insertion in order to measure the field strength in the arc. The probe was a tungsten wire 0.17 mm in diameter, clad in a quartz capillary. The probe remained in the arc only 10 to 20 msec. Experiments were carried out in air at currents I = 40 to 160 amps and mass flow rates G = 5 to 15 g/sec. The probe measurements showed an increase in field strength along the length of the arc in the direction of gas motion. The electric field strength increased from 20 volts/cm at l = 7 cm to 55 volts/cm at l = 21 cm. An attempt is made to explain this increase by the change in properties of the gas on increasing its temperature by heating in the arc. (TTT)

41085 RADIO FREQUENCY SEALER (Engineering Materials). (California Univ., Livermore. Lawrence Radiation Lab.). (CAPE-1642).

29 drawings.

A rf sealer is described which is a lightweight portable unit weighing 14 lbs. The unit is capable of welding from 3 to 12 mils thick polyvinyl chloride including wrinkles caused by bunching. If heat input and length of pulse are regulated, perfect welds are obtained. A small portable hydraulic unit and rf generator are needed to operate the sealer. The unit has a double action trigger used to close the jaws of the sealer and to energize the electrodes. A pressure switch interlock prevents preenergizing the electrodes, preventing arcing and burn through. The lower jaw is full-floating and self-aligning to equalize pressure when wrinkles or bunching occurs. Electrodes are mounted to allow for expansion and contraction eliminating warping. The upper electrode is faced with teflon tape for a buffer preventing arcing when a small bag is welded. A small light indicates when the rf generator is on and the sealer is ready to weld. (For details see TID-4100 Suppl. 42) (F.S.)

41086 BAKEABLE VALVE, 8 IN. (Engineering Materials). (California Univ., Livermore. Lawrence Radiation Lab.). (CAPE-1537).

27 drawings.

An 8 in. bakeable valve is described which is used in the Alice "C" thermonuclear device. The valve consists of a large hydraulic cylinder operating through a welded bellows which moves a carrier plate and gate in a simple rectilinear path. Closure is accomplished by rollers on ramps encountered near the end of the carrier plate travel. The gate carries a Cu disk with a seal surface machined at its outer periphery. The seal must be accomplished against a surface provided on a mating member external to the valve assembly. A rectangular Al foil seal flange permits removal of all valve components for service or replacement without removing the valve from its system. (For details see TID-4100 Suppl. 42.) (F.S.)

41087 ANTIFLASH DEVICE. Abegg, M. T.; Leslie, W. B. (to U. S. Atomic Energy Commission). U. S. Patent 3,342,540. Sept. 19, 1967.

Goggles are described which may be used to quickly shut out light emission of a nuclear explosion. A light sensor actuates a mild explosive so as to quickly disperse opaquing material and render the goggles opaque. (AEC)

41088 IRRADIATION APPARATUS. (to Sulzer Brothers Ltd.). British Patent 1,082,049. Sept. 6, 1967. Priority date Apr. 14, 1964, Switzerland.

An irradiation facility is described which consists of a method for mounting a radiation source, two closed-loop parallel conveyor systems moving in a single plane, a conveyor system for conveying loads to the other two conveyors. The conveyors are loaded and the material is transferred from one conveyor to another in the same direction and in a single working step. (F.S.)

41089 IMPROVEMENTS IN OR RELATING TO GAS TURBINE DRIVEN CIRCULATORS. (to General Dynamics Corp.). British Patent 1,083,173. Sept. 13, 1967. Priority date Aug. 10, 1964, United States.

A gas turbine-driven circulator adapted to be contained in the pressure vessel of a nuclear reactor is described. The turbo-

circulator consists of a thin-walled casing containing a centrally supported rotor with an upper turbine section and a lower compressor section. Gas which has acquired heat energy in the core accelerates into the turbine. It is then decelerated and diffused into the steam generator where heat energy produces steam, it accelerates again into the compressor. From the compressor it decelerates and returns to the reactor core. The compressor and turbine operate on a Brayton cycle to pump reactor coolant gas without thermodynamic penalty and no external energy is required to drive the circulators. (F.S.)

41090 IMPROVEMENTS IN A RELATING TO THERMOPILES. (to Compagnie Des Compteurs). British Patent 1,083,012. Sept. 13, 1967. Priority date Dec. 24, 1963, Japan.

A radiation detector employing a thermopile used in measuring the flux density of radiation in the region of the spectrum extending from the visible to the remote infrared is described. The thermopile structure consists of a film of electrically insulating material having on at least one surface, metallic coating deposits of metal or alloys which overlap on either side of a central line to form two groups of hot and cold junctions connected in series. The film also supports at least one additional deposit of radiation-absorbing material on the surface exposed to radiation. The radiation-absorbing material extends over the zone comprising the coatings forming one of the groups of junctions. Radiation flux density is proportional to the temperature difference. The quality to be measured is proportional to the electromotive force of the thermopile. (F.S.)

41091 DETACHABLE AIR-TIGHT LOCK FOR HANDLING CELLS FOR DANGEROUS OPERATIONS. Basso-Bert, Jean; Pesenti, Pierre; Removille, Jacques (to European Atomic Energy Community). British Patent 1,083,510. Sept. 13, 1967. Priority date Dec. 10, 1963, Belgium.

A detachable air-tight lock for access doors to cells which are used for dangerous materials is described. The lock consists of a tent which is fitted over a door and doorway into a cell to provide an airlock open at two faces at right angles. Means are provided for making air-tight joints around the open faces to the doorway and the floor in front of the doorway. The tent may be made of a plastic material such as polyvinyl chloride and may be fixed to the ground in front of the cell door on two rails for a second γ protection door. (F.S.)

41092 WINDING WITH REDUCED MECHANICAL STRESSES AT THE ENDS THEREOF. Cotsaftis, Michel; Leon, Bruno; Leroux, Pierre (to Commissariat a l'Energie Atomique). British Patent 1,083,484. Sept. 13, 1967. Priority date Nov. 5, 1963, France.

A method is described for winding a coil so as to reduce the mechanical stresses which limit the maximum value of the electromagnetic field generated in the coil. A number of conductors of a solenoid are incorporated in the coil forming central and complementary solenoids. The current density per unit length decreases progressively from the value in the interior of the central solenoid to zero in the complementary solenoid, reducing the mechanical stresses in the windings. (F.S.)

41093 METHOD OF IRRADIATING ARTICLES. Skala, Stephen Francis (to Western Electric Co., Inc.). British Patent 1,083,285. Sept. 13, 1967. Priority date Nov. 29, 1963, United States.

A method for irradiating articles is described by which the area of a collimated beam of radiation is elongated by bending the beam with a magnetic field and moving the magnetic field longitudinally along the beam. The beam is enlarged to encompass the entire surface of the article by coordinating intermittent or continuous longitudinal movement of the article with the movement of the magnetic field. (F.S.)

41094 IMPROVEMENTS IN OR RELATING TO COLLIMATORS FOR RADIOTHERAPY EQUIPMENT. Shewchenko, Alex. British Patent 1,083,402. Sept. 13, 1967. Priority date Jan. 6, 1965, Canada.

A collimator to control the throat size and the angle of divergence in radiotherapy units without the necessity of interchanging individual shield members is described. The collimator consists of two pairs of leaf elements each of which comprises a central web and a number of limbs fabricated of material which is impermeable to radiation. The leaf elements are symetrically placed about the centrol axis of the collimator. The limbs on one leaf element interdigitate limbs on the other leaf. The surfaces of the limbs of each leaf confront the central axis of the collimator and lie in a common plane. (F.S.)

Heat Transfer and Fluid Flow

Refer also to abstracts 41071, 41149, 41154, 41157, and 41588.

41095 (ALO-3632-17) QUARTERLY PROGRESS REPORT IN A THERMAL INSULATION STUDY, APRIL-JUNE 1967. DeWitt, W. D.; Reid, R. L. (Union Carbide Corp., Tonawanda, N. Y. Linde Div.). Aug. 21, 1967. Contract AT(30-1)-3632. 115p. Dep. CFSTI.

A 2000-hr thermal performance test was completed for the copper foil-Refrasil quartz fiber paper combination with no degradation of thermal performance. The test apparatus was revised for air exposure experiments, and air exposure testing of this insulation combination was initiated. Approximately 1730 hr of the scheduled 2000-hr thermal performance test were completed at the end of June 1967 for the tantalum foil-Astroquartz cloth combination. Because of experimental difficulties, the desired hot face temperature of 1800°F could be maintained for 517 hr only. For the remainder of this period, the hot face temperature fluctuated between 1590 and 1463°F. Thermal conductivity data were obtained for the copper foil-copper flake opacified Refrasil quartz fiber paper combination, and approximately 1600 hr of the scheduled 2000-hr thermal performance test were completed with no apparent thermal performance degradation. Thermal conductivity data points were established for the nickel foil-Refrasil quartz fiber paper combination, and approximately 535 hr of the scheduled 2000-hr thermal performance test were completed with no apparent thermal performance degradation. Tensile strength measurements were made on samples of Astroquartz cloth taken from the nickel foil-Astroquartz cloth combination thermal conductivity test. An analytical study was made to determine the effects of air exposure during ground hold conditions on vacuum insulations at operating temperature as applied to typical radioisotope power systems. An analytical study was made to assess the effects of various edge geometries on the thermal performance of insulation segments. The Hastelloy-X vacuum enclosure test specimen completed 2000 hr of testing with no leakage. The test was interrupted at this point for examination of the Hastelloy-X specimen and insulation materials compatibility test samples. (auth)

41096 (EUR-3486.f) MESURE DE LA FRACTION DE VIDE DANS UN ECOULEMENT DOUBLE PHASE NaK-ARGON. (Void Fraction Measurements in a Two-Phase Flow NaK/Argon). Milliot, B.; Lazarus, J.; Navarre, J.-Ph. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Apr. 11, 1967. 63p. (In French). Dep.

Several measuring methods have been proved and calibrated for determining the void fraction in vertical two-phase flow of NaK. The emulsion was created by injecting argon in the liquid metal. Results have been obtained in bubble flow using EM flowmeters, changes in electrical resistance, γ-rays attenuation and two-phase pressure drop. All results are compared with each other and checked with the theoretical model of Marchaterre and Hoglund. As to the slip ratio some difference has been observed. Moreover all results have been plotted in the Lockhart-Martinelli diagram. (auth)

41097 (IRB-2/66) WAERMEUEBERGANG UND DRUCKVERLUST AN AXIAL DURCHSTROEMTEN STABBUENDELN. Kritische Literaturuebersicht: Eigene Messungen. (Heat Transfer and Pressure Losses in Axial Flow-Through Rod Bundles. Critical Literature Review: Some Measurements). Moeller, R. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorbauelemente). Mar. 18, 1966. 24p. (In German). (PSB-192/66). Dep.

For the thermo and hydrodynamic design and for the optimization of the core, the accurate knowledge of the heat transfer and pressure loss values in the fuel element bundles of a steam-cooled fast breeder reactor is necessary. The purpose of the discussion is to propose values on the basis of results presently available for the preliminary calculation of these parameters. Because of the complicated flow ratio in rod bundles with mechanical spacers, the thermo and hydrodynamic behavior can only be experimantally clarified. Therefore some experimental results are added to the literature data. (J.S.R.)

41098 (LA-DC-8659) CRYOGENIC TESTS ON A "TEFLON"-TUBE HEAT EXCHANGER. Thurston, R. S.; Williamson, K. D. Jr., Bronson, J. C. (Los Alamos Scientific Lab., N. Mex.). [1967]. Contract W-7405-eng-36. 10p. (CONF-670801-6). Dep. CFSTI.

From Cryogenic Engineering Conference, Palo Alto, Calif.

Heat exchangers with tubes made of Teflon have been developed for use with fluids which normally foul metal surfaces, but not the flexible walls of Teflon tubes. However, the low thermal conductivity of Teflon can accommodate a sufficiently large temperature drop across a reasonable wall thickness for a cryogen to absorb heat through nucleate boiling instead of film boiling. Estimated Teflon wall thicknesses for nucleate boiling heat transfer with H_2O-lH_2, H_2O-lN_2, and lN_2-lH_2 are 0.035, 0.02, and 0.0058 in.

respectively. A heat exchanger consisting of 140 Teflon tubes, with a 0.10-in. OD, a 0.01-in. wall thickness, and a 15-in. effective length, surrounded by a 1.5-in. stainless steel shell was tested at cryogenic temperatures. In order to avoid leakage at a Teflon-metal interface a special seal was developed. The metal face of the seal contains a pair of concentric ridges of semicircular cross section which deform the Teflon. This seal has held against internal pressures up to 880 psi during thermal cycling between H_2O and lH_2, and up to 1200 psi during thermal cycling between H_2O and lN_2. (auth)

41099 (NYO-3679-1) HEAT TRANSFER AND HYDRAULICS: THE EFFECTS OF SUBCOOLED VOIDS. Quarterly Report No. 1, February-June 1967. Staub, F. W. (General Electric Co., Schenectady, N. Y. Research and Development Center). July 1967. Contract AT(30-1)-3679. 46p. (EURAEC-1911). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

In activities devoted to measurement of the initiation and early development of subcooled void profiles of low pressure boiling water, including the design of the loop and test section are described. The facility for the test equipment was prepared and the loop constructed except for insulation and electrical wiring of the major components. Bench tests of the pressure measurement technique in an air-water loop were completed and bench tests of the liquid temperature measurement were begun. Test section drafting is in progress and the power supply with control components and wiring are yet to be completed. Void fraction profiles will be determined by x-ray beam attenuation techniques to obtain transverse and axial void profiles. Well-type manometers having 40-in. equivalent water scale with a reading accuracy of ±0.002 in. will be employed to measure static pressures. Liquid velocity profiles in bubbly flow will be analyzed mathematically. Small traversing thermocouples with adequate immersion length will measure temperature profiles. The test section for measurements with water at high pressure was started. Details of the pressure taps are being completed. (F.S.)

41100 (UCRL-17527) MASS AND HEAT TRANSFER PROCESSES IN LAMINAR, TWO-PHASE FLOW. Clark, Michael W.; King, C. Judson (California Univ., Berkeley. Lawrence Radiation Lab.). June 1967. Contract W-7405-eng-48. 164p. Dep. CFSTI.

Thesis. Submitted by Michael W. Clark.

High flux and high concentration level heat and mass transfer experiments have been carried out for several gas-liquid systems which exhibited resistance to transfer in both the liquid and gaseous phases. These experiments were carried out in a horizontal, rectangular duct of high aspect ratio, in which the gaseous and liquid phases were contacted while moving in stratified, laminar cocurrent flow. A calculational method, which utilizes the principle of addition of the individual phase resistances in a trial and error manner, was developed and utilized to predict the interphase high flux, high concentration level mass transfer behavior of the system. In order to ascertain the gas phase resistance of this model accurately, the equation of convective diffusion was solved numerically for the case of a finite interfacial mass flux (high flux) combined with a linear velocity profile away from the mass transfer interface (the Leveque model). The flux level correction factor obtained from this solution, which differed very little from the penetration model correction factor, was confirmed experimentally by evaporating isopentane and n-pentane into a flowing nitrogen stream. During the course of the interphase mass transfer experiments a large reduction in the liquid phase resistance to mass transfer was observed at higher concentration levels of the volatile components. This reduction was ultimately traced to a form of cellular convection in the liquid phase which appeared to be driven by surface tension variations brought about by the concentration gradients existing in the system. The effect of this type of cellular convection upon the experimentally observed, liquid-phase mass transfer coefficients for several systems was well represented by a single correlation involving the Thompson number. (auth)

41101 (UCRL-50294) HEAT PIPE RADIATOR FOR A 50-MWt SPACE POWER PLANT. Werner, Richard W.; Carlson, Gustav A. (California Univ., Livermore. Lawrence Radiation Lab.). June 30, 1967. Contract W-7405-eng-48. 38p. Dep. CFSTI.

The concept and design of a heat pipe radiator suitable for high power levels of approximately 50 MW(t) are discussed. Design considerations include meteoroid protection, heat transfer, stress, fluid flow, pressure drop, etc. A representative heat pipe design is shown to reject 46 MW at 1100°K using a total mass of 13,220 kg for a specific weight of 1.322 kg/kW(e). The radiator is used as part of a Rankine-cycle nuclear reactor power plant suitable for a manned Mars mission of 10,000 hours. (auth)

41102 SUPERCRITICAL THERMODYNAMIC POWER CYCLE. Feher, Ernest G. (Douglas Aircraft Co., Santa Monica, Calif.). pp 37-44 of Advances in Energy Conversion Engineering. New York, American Society of Mechanical Engineers, 1967.

From 2nd Intersociety Energy Conversion Engineering Conference, Miami Beach, Fla., Aug. 13-17, 1967. See CONF-670806.

A thermodynamic power cycle is discussed, which operates entirely above the critical pressure of the working fluid. This Supercritical Cycle is regenerative and the compression process is performed in the liquid phase. The result is high cycle efficiency, as shown by typical cycle calculations carried out for carbon dioxide as the working fluid. An engine based on this cycle would be very compact due to the high working fluid density. It can be used for electric power generation and to produce shaft power for propulsion. (auth)

41103 SUMMARY OF NASA RADIAL TURBINE RESEARCH RELATED TO BRAYTON CYCLE SPACE POWER SYSTEMS. Rohlik, H. E.; Kofskey, M. G.; Katsanis, T. (Lewis Research Center, Cleveland). pp 45-54 of Advances in Energy Conversion Engineering. New York, American Society of Mechanical Engineers, 1967.

From 2nd Intersociety Energy Conversion Engineering Conference, Miami Beach, Fla., Aug. 13-17, 1967. See CONF-670806.

Progress at the Lewis Research Center is reported in new techniques for turbine analysis and experimental investigations of turbine performance. Radial-flow turbines were investigated for effects of size, Reynolds number, and specific speed on efficiency and flow. Results indicate that turbines for wide ranges of operating variables may be designed with a reasonable certainty of achieving high efficiency. (auth)

41104 RANKINE CYCLE BOILER AND CONDENSER-RADIATOR ORBITAL EXPERIMENT. Vild, T. J. (TRW Equipment Labs., Cleveland); McKinnon, R. A.; Delaney, C. L. pp 77-85 of Advances in Energy Conversion Engineering. New York, American Society of Mechanical Engineers, 1967.

From 2nd Intersociety Energy Conversion Engineering Conference, Miami Beach, Fla., Aug. 13-17, 1967. See CONF-670806.

A small scale simulated Rankine cycle power conversion system was designed, built, and ground tested prior to injection into a near-earth orbit. The system, using potassium as the working fluid, was composed of a positive displacement pump, a once-through forced convection electrically heated boiler, and a parallel flow direct condenser-radiator. A turbine was simulated by the combination of an orifice and a desuperheater. The system was subjected to environmental, radiofrequency interference and performance tests on the ground. Typical ground system performance results are presented together with initial results of the orbital test. (auth)

41105 LITHIUM-BOILING POTASSIUM RANKINE CYCLE TEST LOOP OPERATING EXPERIENCE. Davis, Jerry P.; Kikin, Gerald M. (California Inst. of Tech., Pasadena). pp 87-95 of Advances in Energy Conversion Engineering. New York, American Society of Mechanical Engineers, 1967.

From 2nd Intersociety Energy Conversion Engineering Conference, Miami Beach, Fla., Aug. 13-17, 1967. See CONF-670806.

A description is presented of the instrumentation and initial phases of operation of a lithium-boiling potassium test loop. The primary purpose of this facility is to investigate overall transient and steady-state characteristics, startup, control, and stability of a two-loop, alkali metal, Rankine cycle system of the type contemplated for ultimate application to spacecraft nuclear-electric propulsion. The loop, constructed of Nb 1% Zr, operates at 30 kW heat input and temperatures up to 2100°F. The primary-loop heat source, which is by electric-current-resistance heat generation in a section of the tube wall, may be programmed to nuclear-reactor kinetic equations for simulation of power response to various system perturbations. The secondary loop includes a refractory-metal, single-wheel, reentry-type turboalternator. (auth)

41106 POTASSIUM TURBINE EROSION EXPERIMENTS. Linhardt, H. D.; Smisek, R. F.; Baenteli, G. J. (Philco-Ford Corp., Newport Beach, Calif.). pp 97-102 of Advances in Energy Conversion Engineering. New York, American Society of Mechanical Engineers, 1967.

From 2nd Intersociety Energy Conversion Engineering Conference, Miami Beach, Fla., Aug. 13-17, 1967. See CONF-670806.

Results of a turbine test using supersonic K vapor are discussed. The test facilities and turbines are described. Experimental results indicate that supersonic single-stage alkali metal vapor turbines are potentially superior to subsonic designs due to the submicron size of the primary condensate droplets. (J.R.D.)

41107 DEVELOPMENT PROGRESS OF ORGANIC RANKINE CYCLE POWER SYSTEMS. Linhardt, Hans D.; Carver, George P. (Philco-Ford Corp., Newport Beach, Calif.). pp 103-15 of Advances in Energy Conversion Engineering. New York, American Society of Mechanical Engineers, 1967.

From 2nd Intersociety Energy Conversion Engineering Conference, Miami Beach, Fla., Aug. 13–17, 1967. See CONF-670806.

Substantial progress has been made in demonstrating the feasibility of monoisopropylbiphenyl (MIPB) organic-cycle power systems. Such systems have the advantage of low pressure, are insensitive to terrestrial environments and do not require exotic materials. They are adaptable to any desirable heat source. They are reliable, quiet and show promise of short system development time. It is expected that the MIPB organic type of power plant will provide a sound and realistic engineering solution for a low-mantenance silent military power unit and will be a candidate for future low power output dynamic space power systems. (auth)

41108 CURRENT STATUS OF THE TECHNOLOGY OF ORGANIC RANKINE CYCLE POWER PLANTS. Luchter, Stephen (Mechanical Tech. Inc., Latham, N. Y.). pp 117-21 of Advances in Energy Conversion Engineering. New York, American Society of Mechanical Engineers, 1967.

From 2nd Intersociety Energy Conversion Engineering Conference, Miami Beach, Fla., Aug. 13–17, 1967. See CONF-670806.

Several organic Rankine cycle power plants have been designed or developed for particular applications, with little of the work reported in the open literature. Particularly absent are discussions of the fundamental technology which is generally applicable to all power plants of this type. The results of a survey of the status of the technology base upon which to design organic Rankine cycle power plants are presented. The cycle performance is compared with other cycles, and the status of the technology areas upon which the organic Rankine cycle is based are discussed including working fluids, process fluid lubrication, seals, rotor bearing dynamics, erosion and cavitation, high speed alternators, power conditioning, mechanical transmissions, aerodynamics, heat transfer, and materials. (auth)

41109 CRITERION FOR MINIMUM WEIGHT CARNOT LIMITED SPACE POWER SYSTEMS. Bjerklie, John W. (Mechanical Tech. Inc., Latham, N. Y.). pp 123-33 of Advances in Energy Conversion Engineering. New York, American Society of Mechanical Engineers, 1967.

From 2nd Intersociety Energy Conversion Engineering Conference, Miami Beach, Fla., Aug. 13–17, 1967. See CONF-670806.

A criterion is presented for estimating the optimum heat rejection temperature for heat-operated space power systems taking into account peak temperature and weights of the heat source and heat rejection components. Good agreement is found between operating points of minimum weight systems and those derived with the optimizing criterion. The method is applied to a number of hypothetical 35-kW Rankine and Brayton cycles to verify minimum weight systems. Binary Rankine systems are lightest. Single fluid Rankine systems with steam or organic fluids tend to be lightest with high specific heat source weight. High temperature Rankine systems are lightest with low specific heat source weights. (auth)

41110 FEASIBILITY STUDY OF ROTATING BOILER FOR HIGH-PERFORMANCE RANKINE CYCLE POWER GENERATION SYSTEMS. Gray, Vernon H. (Lewis Research Center, Cleveland). pp 145-9 of Advances in Energy Conversion Engineering. New York, American Society of Mechanical Engineers, 1967.

From 2nd Intersociety Energy Conversion Engineering Conference, Miami Beach, Fla., Aug. 13–17, 1967. See CONF-670806.

A small-scale experimental study of the feasibility of a rotating boiler was undertaken using water as test fluid. Rotational accelerations up to 500 gravities were investigated. High speed photographs of the boiling fluid were taken and heat-transfer coefficients were obtained. The tests demonstrated advantages of rotating boilers, such as stable interface between liquid and vapor, high exit vapor quality, high heat flux rates, and freedom from gravity field and orientation. A concept for heating a rotating boiler with a liquid flowing in a surrounding annulus is discussed. Advantages and problems with this application are considered using an example of a boiler rotating at 14,000 rpm. (auth)

41111 DEVELOPMENT OF FOIL THERMAL INSULATION FOR HIGH-TEMPERATURE HEAT SOURCES. Dunlay, John B. (Thermo Electron Engineering Corp., Waltham, Mass.). pp 171-6 of Advances in Energy Conversion Engineering. New York, American Society of Mechanical Engineers, 1967.

From 2nd Intersociety Energy Conversion Engineering Conference, Miami Beach, Fla., Aug. 13–17, 1967. See CONF-670806.

A description is presented of current work on the development of high-temperature thermal insulation. The insulation consists of thin foils of refractory metals separated by thin layers of high-purity refractory oxides. The metal foils serve as thermal radiation shields, and the oxide layers provide thermal resistance barriers to prevent conduction between the metal foils. Compatibility tests were conducted to investigate possible interactions between the foil and oxide materials for long-term operation at 1700°C and short-term operation at 1900°C. Heat-transfer tests are now in progress to evaluate the thermal performance of the insulation for hot-side temperatures up to 1700°C. (auth)

41112 HEAT CONDUCTIVITY OF THE BOUNDARY LAYER OF LIQUID-METAL COOLANT CURRENTS. Ivanovskii, M. N.; Orlov, Yu. I.; Subbotin, V. I. At. Energ. (USSR), 22: 231-3 (1967). (In Russian).

The appearance of a contact resistance causes the reduction of the heat flow from the pipe wall to the liquid metal flowing in it by a factor of about 2. Analysis of the factors affecting the heat transfer and experimental study of liquid lithium systems revealed that the main reason for this behavior lies in the accumulation of insoluble impurities in the boundary layer, resulting in the reduction of the heat conductivity. Extreme loading of the liquid metal stream with lithium nitride impurity, up to the complete plugging of the loop did not cause the theoretically expected maximum reduction in the heat transfer and the corresponding temperature changes in the boundary layer; this indicated that the contact resistance reaches a maximum, depending on the prevailing Reynold's number. The heat conductivity of lithium containing up to 29 wt % of nitrogen in the form of lithium nitride amounted to 6 to 8 kcal/m. hr.°C at 300°C, while that of pure lithium was 40 kcal/m. hr.°C. The model applies only to systems in which no crystallization occurs on the wall. (TTT)

41113 STUDIES ON BURNOUT. PART 3. A NEW CORRELATION FOR ROUND DUCTS AND UNIFORM HEATING AND ITS COMPARISON WITH WORLD DATA. Biasi, L. (ARS SpA, Milan, Univ., Milan); Clerici, G. C.; Garribba, S.; Sala, R.; Tozzi, A. Energ. Nucl. (Milan), 14: 530-6(Sept. 1967).

A new burnout correlation having a large range of validity and applicable to circular ducts with uniform heat flux distribution is described. The predicted values are compared with nearly all the burnout data with negative inlet quality ($X_{in} < 0$) presently available. The resulting mean quadratic error of over 4551 experimental data is 7.26% while 85.5% of the examined data has an absolute error less than 10%. A study of the error dependence on the various parameters is also presented. (auth)

41114 UNSTEADY-STATE HEAT GENERATION AND HEAT TRANSFER IN SUPERCONDUCTING COMPOSITES. Gardner, G. C. (Central Electricity Research Labs., Surrey, Eng.). Int. J. Heat Mass Transfer, 10: 1055-64(Aug. 1967).

Approximate methods were developed to calculate the rate of heat generation with respect to time when current is suddenly discharged from part of a superconducting wire embedded in a copper sheath. The temperature field in the copper with respect to time is then found in the absence of any cooling from liquid helium surrounding the superconducting composite. Thus it is determined if the temperature at the end of the section of superconductor, from which the current has been excluded, rises above a critical temperature which will cause the region to propagate. Unsteady-state film boiling of liquid helium is separately considered to determine if it can make a significant contribution to modifying the temperature field within the superconducting composite. The film boiling theory is put in a form readily applicable to liquids other than helium. (auth)

41115 MANUFACTURE OF FINNED TUBE FOR HIGH-PRESSURE GAS SYSTEMS. Wright, R. (Tube Investments, Ltd., Walsall, Eng.). Chem. Process Eng., 157-9(Aug. 1967).

The increasing use of gas as a heat transfer medium, especially at high pressures, has stimulated a keen interest in extended-surface heat exchangers. Practical design of such surfaces is governed by what can be produced economically, as well as by the art of achieving optimum transfer for each system configuration. The state-of-the-art in this field is reviewed. (auth) (UK)

41116 HEAT EXCHANGER FOULING WITH DUST SUSPENSIONS. Hawes, R. I.; Garton, D. A. (Atomic Energy Establishment, Winfrith, Eng.). Chem. Process Eng., 143-5; 50(Aug. 1967).

Much interest has been provoked by the problem of surface fouling by gas/solid suspensions, where the heat contained in the fluid is transferred to and through them. The problem is reviewed in detail, in the light of the functions of heat exchangers, and a num-

ber of related characteristics are indicated which will help to minimise the fouling of the surfaces of heat exchangers by flowing gas/solid suspensions. (auth) (UK)

41117 GAS-SIDE HEAT TRANSFER: MEASUREMENT AND PREDICTION. Fallon, T. A. Chem. Process Eng., 147-50(Aug. 1967).

Designers are able to produce technically sound, economically justified heat transfer equipment, given data from the measurement and correlation of gas-side heat transfer and pressure loss. It is indicated how this information is obtained, and the rigs and techniques used in an industrial heat transfer laboratory to investigate the performance of plain and finned tubes, as applied to gas-cooled reactor boiler design, are described. (auth) (UK)

41118 THIRD INTERNATIONAL HEAT TRANSFER CONFERENCE, CHICAGO. Kearsey, H. A. (Atomic Energy Research Establishment, Harwell, Eng.). Chem. Process Eng., 153-4(Aug. 1967).

A brief account of this Conference, held on August 7–12th 1966, and organised jointly by the American Society of Mechanical Engineers, the American Institute of Chemical Engineers, the Institution of Mechanical Engineers (UK), and the Institution of Chemical Engineers (UK), is given under the headings single-phase heat transfer, heat exchanger performance, burn-out, extended surfaces, and film boiling and related topics. (UK)

41119 PROGRESS IN HEAT TRANSFER: REVIEW OF 1966 LITERATURE. Grant, I. D. R. (National Engineering Lab., Glasgow). Chem. Process Eng., 125-35(Aug. 1967).

Over 300 references are reviewed under the following main sections — conduction, radiation, convection, change of phase, heat exchanger dynamics, unsteady heat transfer, and heat exchangers. (UK)

41120 DEPARTURE FROM NUCLEATE BOILING ON A FINNED-SURFACE HEATER ROD. Tong, L. S.; Kitzes, A. S.; Green, J.; Stormer, T. D. (Westinghouse Electric Corp., Pittsburgh). Nucl. Eng. Design, 5: 386-90(July 1967).

Tests have been performed to determine the DNB heat fluxes and post-DNB heat transfer coefficients on a single uniformly electric heated rod centered in an unheated square channel. The heated rod has a series of 0.0025 in. high fins at the downstream end. Test results are presented for the upward flow of water at pressures of 1600 to 2300 psia, inlet temperatures of 520 and 600°F and flow rates of 1.0 to 3.0×10^6 lb/hr ft^2. They show that the DNB heat flux is not affected by the fins in the subcooled region. The post-DNB heat transfer is improved by the fins. (auth)

41121 APPLICATION OF A BOILING WATER LOOP MODEL TO BOILING SODIUM. Bogaardt, M.; Spigt, C. L. (Technological Univ., Eindhoven, Netherlands). Nucl. Eng. Design, 5: 465-76(July 1967).

Results are given of an analytical study on the applicability to a boiling sodium system of existing physical-mathematical formulations for the performance characteristics of a boiling water system under steady or transient conditions. Furthermore, the effect of liquid superheat on the calculated performance characteristics has been evaluated. It is shown that the application of theoretical models developed for water systems to liquid metal systems does not lead to difficulties but that the effect of liquid superheat should be taken into account in case appreciable superheats are found to occur. (auth)

41122 BOILING HEAT TRANSFER IN STEAM-GENERATING UNITS AND HEAT EXCHANGERS. A Symposium Arranged by the Nuclear Energy, Steam Plant, and Thermodynamics and Fluid Mechanics Groups, held at the Manchester College of Science and Technology, Manchester, England, 15th–16th September 1965. Proc. Inst. Mech. Eng. (London), 180: Pt 3C, 1-290(1965-66). (CONF-650988).

Twenty-one papers were presented at the symposium. A separate abstract was prepared for each paper. (J.R.D.)

For abstracts of individual papers see: 41123–41143.

41123 A REVIEW OF THE APPLICATION OF BOILING HEAT TRANSFER DEVELOPMENTS TO PLANT PROBLEMS. Firman, E. C.; Gardner, G. C.; Clapp, R. M. (Central Electricity Research Labs., Leatherhead, Eng.). Proc. Inst. Mech. Eng. (London), 180: Pt 3C, 1-15(1965-66).

From Symposium on Boiling Heat Transfer in Steam-Generating Units and Heat Exchangers, London, Sept. 15–16, 1965. See CONF-650988.

Problems currently encountered in the boiling heat transfer field are outlined. In general an attempt has been made to concentrate on the heat transfer aspects rather than the associated problems of two-phase flow. A résumé is given of the more common boiling phenomena, together with discussions of design problems and heat transfer fundamentals. The subject of burn-out and the associated phenomenon of hydrodynamic instability are reviewed. Discussion is included concerning scaling and corrosion in boiling situations and the evaporation of heat sensitive liquids. A brief summary of problems still outstanding in the boiling field is included. (J.R.D.)

41124 SCALING OF BURN-OUT IN FORCED CONVECTION BOILING HEAT TRANSFER. Barnett, P. G. (Atomic Energy Establishment, Winfrith, Eng.). Proc. Inst. Mech. Eng. (London), 180: Pt 3C, 16-26(1965-66).

From Symposium on Boiling Heat Transfer in Steam-Generating Units and Heat Exchangers, London, Sept. 15–16, 1965. See CONF-650988.

The possibility of using model techniques in forced-convection boiling heat transfer is examined and a method indicated whereby the important physical properties, at present unknown, may be identified. The method has been used to test possible sets of scaling laws with burn-out data for water, dichlorodifluoromethane and dichlorofluoromethane and a particular set has been found which links the results to within ±7 per cent. This set includes properties such as latent heat of vaporization, liquid and vapor densities, thermal conductivity and specific heat of the liquid, and the rate of change of the density ratio with pressure. However, there are indications that at least one more property must be added if more accurate scaling is required and this property is probably the rate of change of the saturation temperature with pressure. (auth)

41125 AN EXPERIMENTAL INVESTIGATION OF BURN-OUT WITH FORCED CONVECTION HIGH-PRESSURE WATER. Lee, D. H.; Obertelli, J. D. (United Kingdom Atomic Energy Authority, Winfrith, Eng.). Proc. Inst. Mech. Eng. (London), 180: Pt 3C, 27-36(1965-66).

From Symposium on Boiling Heat Transfer in Steam-Generating Units and Heat Exchangers, London, Sept. 15–16, 1965. See CONF-650988.

The experimental techniques used to investigate burn-out are reviewed pointing out where differences between rig types may give varying results. The relations between the burn-out heat flux and the inlet sub-cooling, mass velocity, pressure, and the geometry of the heated channel are described, with emphasis on regimes where such general trends are known to be inapplicable. The burn-out powers for channels with uniform and non-uniform axial heat flux distributions are shown to be generally similar; again the known exceptions are defined. The problems of measurement of burn-out in large rod clusters are examined and the trends of such data are discussed. Correlations are recommended for burn-out in single tubes and rod clusters. (auth)

41126 APPRAISAL OF FORCED CONVECTION BURN-OUT DATA. Macbeth, R. V. (United Kingdom Atomic Energy Authority, Winfrith, Eng.). Proc. Inst. Mech. Eng. (London), 180: Pt 3C, 37-50(1965-66).

From Symposium on Boiling Heat Transfer in Steam-Generating Units and Heat Exchangers, London, Sept. 15–16, 1965. See CONF-650988.

A vast amount of burn-out data representing a wide variety of boiling channels and operating conditions has accumulated during the past decade. Something like 13,000 experimental results have been published and have given rise to the necessity for an overall appraisal. The difficulties of analyzing forced convection burn-out data are such that there is no established theoretical explanation of the phenomenon. The number of burn-out variables is large, and the data are mostly unsystematic owing to the way in which experiments have been performed. By persistent examination, however, the important behavior patterns have been identified and a successful method of correlating the data has emerged. (auth)

41127 APPLICATION OF HEAT TRANSFER DATA TO THE DESIGN OF ONCE-THROUGH BOILER FURNACES. Bagley, R. (Babcock and Wilcox Ltd., London). Proc. Inst. Mech. Eng. (London), 180: Pt 3C, 51-62(1965-66).

From Symposium on Boiling Heat Transfer in Steam-Generating Units and Heat Exchangers, London, Sept. 15–16, 1965. See CONF-650988.

Discussions are including concerning basic furnace design, heat transfer inside furnace tubes, and heat conduction through the tube walls. It is noted that the metal tube temperature calculations in once-through subcritical boilers are cumbersome and imprecise. However, furnaces designed using these methods are operating satisfactorily and precedents are available on which future designs can be based. (J.R.D.)

41128 HEAT TRANSFER DURING EVAPORATION OF LOW QUALITY WATER–STEAM MIXTURES FLOWING IN HORIZONTAL TUBES. Rounthwaite, C.; Clouston, M. (Wrightson and Co. Ltd., Thornaby-on-Tees, Eng.). Proc. Inst. Mech. Eng. (London), 180: Pt 3C, 63-76(1965-66).

From Symposium on Boiling Heat Transfer in Steam-Generating Units and Heat Exchangers, London, Sept. 15–16, 1965. See CONF-650988.

The experiments described were designed to simulate the conditions in the evaporator sections of natural and forced circulation boilers for gas-cooled nuclear power stations. The test-section was in the shape of a horizontal hairpin constructed from 1.6 in.-bore mild steel tube. Each leg was 20 ft in length and could be heated electrically to provide heat fluxes up to 25,000 Btu/h ft^2. The test section was connected to a steam generator which provided a steam-water mixture containing up to 30 per cent by weight steam at pressures up to 950 lb/in.^{2} gage and at peak flow rates of 8000 lb/hr. The pressure, flow rate, heat flux, and mean steam quality in the test section were all varied systematically, and thermocouples attached to the outside of the tubes accurately recorded the tube wall temperature, enabling the corresponding local heat transfer coefficients to be deduced. The results showed that the two-phase heat transfer coefficients were primarily dependent on heat flux, but that steam pressure and flow rate only had minor influence. Increasing the steam quality from 0 to 30 per cent also had little effect on the mean values of the coefficient. However, there was an appreciable variation of heat transfer coefficient around the tube section under all conditions, the value at the top generally being higher than at the bottom. It is concluded that within the experimental range considered a nucleate boiling mechanism was mainly responsible for the heat transfer process, though there was evidence of a forced convection regime predominating at higher steam velocities in the tube. On the other hand, at low steam velocities a distinct stratification of the two phases occurred, with the steam uppermost. (auth)

41129 ON THE HEAT TRANSFER AND FLUID FLOW CHARACTERISTICS IN A BOILING CHANNEL UNDER CONDITIONS OF NATURAL CONVECTION. Bogaardt, M.; Spigt, C. L.; Dijkman, F. J. M.; Verheugen, A. N. J. (Technological Univ. of Eindhoven, Netherlands). Proc. Inst. Mech. Eng. (London), 180: Pt 3C, 77-87(1965-66).

From Symposium on Boiling Heat Transfer in Steam-Generating Units and Heat Exchangers, London, Sept. 15–16, 1965. See CONF-650988.

Descriptions are presented of the investigation aims, the experimental set-up, and the measuring and analyzing techniques. Results of natural circulation experiments at 14 to 450 lb/in.^{2}, 0 to 300 kW power dissipation, and inlet sub-cooling of 0 to 40°C on single rod annular geometries simulating fuel channels in boiling water reactors are included. Data on the steam-void and pressure distribution along the height of the channel are given together with slip ratios and two-phase pressure drops calculated from the experimental results. The steam-void fluctuations have been analyzed suggesting a slug-type flow being present. Results are given for the onset of hydraulic oscillations. The threshold powers are compared with those obtained from theoretical calculations. The maximum obtained heat transfer rates in these experiments are discussed and an outline is presented of subsequent programs. (auth)

41130 NUCLEATION AND BUBBLE FORMATION IN BOILING. Griffith, Peter (Massachusetts Inst. of Tech., Cambridge). Proc. Inst. Mech. Eng. (London), 180: Pt 3C, 93-9 (1965-66).

From Symposium on Boiling Heat Transfer in Steam-Generating Units and Heat Exchangers, London, Sept. 15–16, 1965. See CONF-650988.

Bubble nucleation in boiling is shown to take place from gas-filled cavities on the heating surface. Thermodynamic relations and wall temperature gradient are sufficient to predict when nucleation will occur from a cavity with a pre-existing gas phase. The stability of boiling cavities is found to be so sensitive to the details of cavity geometry and contact angle as to defy simple description. Nucleation in alkali metals is found to be similar to that occurring in other fluids except that the low contact angle reduces the number of stable cavities. With alkali metals there are inexplicable reductions in the wall superheat needed to sustain boiling when steady boiling occurs. (auth)

41131 REVIEW OF EXPERIMENTAL PROGRESS IN THE STUDY OF CONVECTIVE BOILING. Lacey, P. M. C. (Univ. of Exeter, Eng.); Kirby, G. J. Proc. Inst. Mech. Eng. (London), 180: Pt 3C, 101-11(1965-66).

From Symposium on Boiling Heat Transfer in Steam-Generating Units and Heat Exchangers, London, Sept. 15–16, 1965. See CONF-650988.

Progress made during recent years toward understanding the behavior of water undergoing evaporation while flowing in tubes is reviewed. Conditions found in high pressure boilers are discussed on the basis of up-to-date flow-pattern charts which emphasize the prevalence of annular flow conditions. The dominant mode of heat transfer is evaporation of water films on heated surfaces, although most of the water may be flowing in the form of entrained droplets. Curvature of the water tubes leads to the deposition of this material and probably renders them less sensitive to burn-out than would be predicted from correlations available for straight tubes. Localized areas of nucleate boiling must, however, occur and these, in conjunction with solid deposits, could encourage the corrosion phenomena encountered in such systems. (auth)

41132 FLOW PATTERNS NEAR NUCLEI AND THE INITIATION OF BOILING DURING FORCED CONVECTION HEAT TRANSFER. Kenning, D. B. R. (Oxford Univ.); Cooper, M. G. Proc. Inst. Mech. Eng. (London), 180: Pt 3C, 112-23(1965-66).

From Symposium on Boiling Heat Transfer in Steam-Generating Units and Heat Exchangers, London, Sept. 15–16, 1965. See CONF-650988.

An investigation is described in which the flow patterns near vapor bubble nuclei in forced convection boiling heat transfer were modeled on a large scale by the flow past air bubbles. The flow was found to be affected by variations in surface tension on bubble surfaces. The experimental observations are used to deduce the surface temperature of nuclei when local heat transfer is predominantly by convection. The wall temperature required to initiate boiling under these conditions is determined and compared with estimates for the other limiting condition where the temperatures of the nuclei are governed by conduction in the surrounding liquid only. The theoretical results are plotted with published experimental data on a graph of $(T_w - T_s)(KV^*/Qv)$ against AKV^{*2}/Qv^2. Over the range $0.6 < AKV^{*2}/Qv^2 < 20$, the data are correlated with an accuracy of ±50 per cent by the expression $(T_w - T_s)(KV^*/Qv) = 1.33(AKV^{*2}/Qv^2)^{0.6}$. (auth)

41133 THICKNESS OF THE THERMAL LAYER AT THE INITIATION OF NUCLEATE POOL BOILING. Grant, I. D. R. (Babcock and Wilcox Ltd., Renfrew, Eng.); Patten, T. D. Proc. Inst. Mech. Eng. (London), 180: Pt 3C, 124-34(1965-66).

From Symposium on Boiling Heat Transfer in Steam-Generating Units and Heat Exchangers, London, Sept. 15–16, 1965. See CONF-650988.

An investigation of water is described in which the growth and development of thermal layers were observed and their thickness measured prior to nucleate boiling initiation. Measurements made using a shadowgraph technique revealed that in the absence of boiling and for low values of temperature differences between the heating surface and the bulk liquid, the upper surface of the layer is smooth. A wave motion develops with increase of temperature difference until upper parts of the wave are shed due to buoyancy. (J.R.D.)

41134 A STUDY OF NUCLEATION PHENOMENA IN TRANSIENT POOL BOILING. Simpson, H. C.; Walls, A. S. (G. and F. Weir Ltd., Glasgow). Proc. Inst. Mech. Eng. (London), 180: Pt 3C, 135-49(1965-66).

From Symposium on Boiling Heat Transfer in Steam-Generating Units and Heat Exchangers, London, Sept. 15–16, 1965. See CONF-650988.

The transfer of heat from platinum wires submerged in water or organic liquids, through which sudden pulses of electrical energy were passed, was used as a means of measuring the critical superheat required to cause boiling in the bulk of the liquid. Tests were carried out over a range of heating rates, sub-coolings, and pulse times. Using the wires as resistance thermometers, the temperature-time history of the wires was analyzed to give the temperatures at which changes in the heat transfer mechanisms took place. It is concluded that the pulsed wire technique can be used to measure the superheat required for homogeneous nucleation of some organic liquids, but is not suitable for water, emphasizing the known tendency of water to boil on solid surfaces. (J.R.D.)

41135 TEMPERATURE FLUCTUATIONS AT A HEATED SURFACE SUPPORTING POOL BOILING OF WATER. Madsen, N. (Technological Univ. of Eindhoven, Netherlands). Proc. Inst. Mech. Eng. (London), 180: Pt 3C, 150-9(1965-66).

From Symposium on Boiling Heat Transfer in Steam-Generating Units and Heat Exchangers, London, Sept. 15–16, 1965. See CONF-650988.

Results of a study of the temperature fluctuations observable at horizontal heat-transfer surfaces during pool boiling are reported. The boiling fluid was water and the pressure nearly atmospheric. Distinctive temperature dips were observed at 16,000 Btu/h ft^2 to burn-out flux, and an occasional very large and fast dip in the stable film boiling regime. A mechanism for the nucleate boiling temperature dips is suggested. (auth)

41136 THE INFLUENCE OF SURFACE ROUGHNESS AND A WETTING ADDITIVE ON POOL BOILING ON HORIZONTAL

RODS. Hall, I. S.; Hatton, A. P. (Univ. of Manchester, Eng.). Proc. Inst. Mech. Eng. (London), 180: Pt 3C, 160-79(1965-66).

From Symposium on Boiling Heat Transfer in Steam-Generating Units and Heat Exchangers, London, Sept. 15–16, 1965. See CONF-650988.

Tests of the validity of correlations for nucleate boiling which have been proposed accounting different grades of surface finish are reported. Boiling experiments at atmospheric pressure were carried out on electrically heated horizontal rods with various surface finishes. A number of different fluids were tested, including distilled water with and without a wetting additive. Photographic studies were also made to determine bubble structure and departure diameter which are factors relevant to the correlations. No correlation was entirely successful when applied to the results for the different surfaces, and a further type of correlation is proposed which appears to offer a greater possibility of success. The photographic studies show that the addition of a wetting additive greatly influences the vapor geometry and apparently suppresses the onset of coalescence. (auth)

41137 EFFECTS OF SOLID ADDITIVES ON THE SATURATED POOL BOILING OF WATER. Hampson, H.; Turton, J. S.; Sutherland, L. A. (Univ. of Aberdeen, Scotland). Proc. Inst. Mech. Eng. (London), 180: Pt 3C, 180-8(1965-66).

From Symposium on Boiling Heat Transfer in Steam-Generating Units and Heat Exchangers, London, Sept. 15–16, 1965. See CONF-650988.

Experimental results of saturated pool boiling heat transfer from a horizontal stainless steel tube are reported. Powdered graphite, precipitated silica, and emery powder were added in turn to pure water as examples of fine powdered insoluble solids. The effects of these additives on the boiling process were studied. In the cases of powdered graphite and precipitated silica a film was formed on the tube surface during the boiling process. Considerable increases in the critical heat flux were observed and were found to be attributable to the presence of the surface film containing the additive. (auth)

41138 CALEFACTION SPOTS ON A HEATING WALL: TEMPERATURE DISTRIBUTION AND RESORPTION. Semeria, R.; Martinet, B. (CEN, Grenoble, France). Proc. Inst. Mech. Eng. (London), 180: Pt 3C, 192-205(1965-66).

From Symposium on Boiling Heat Transfer in Steam-Generating Units and Heat Exchangers, London, Sept. 15–16, 1965. See CONF-650988.

Dry spots forming on hot walls cooled by liquids indicate conditions that may result in the wall temperatures locally exceeding the calefaction temperature. Analytical and experimental investigation of such calefaction spots (especially as regards their resorption) has shown the essential effect involved to be overspilling, by conduction, of heat generated and stored in the wall from the dry to the wet part. The parameters to be considered, therefore, are the thermal properties of the wall, the internal heat release and the heat transfer coefficients. It has been found that satisfactory heat transfer coefficients are possible near the interface, where the thermal gradient is high. (auth)

41139 BURN-OUT AND FILM FLOW IN THE EVAPORATION OF WATER IN TUBES. Hewitt, G. F. (Atomic Energy Research Establishment, Harwell, Eng.); Kearsey, H. A.; Lacey, P. M. C.; Pulling, D. J. Proc. Inst. Mech. Eng. (London), 180: Pt 3C, 206-15(1965-66).

From Symposium on Boiling Heat Transfer in Steam-Generating Units and Heat Exchangers, London, Sept. 15–16, 1965. See CONF-650988.

Experiments are described on the hydraulic characteristics of the two-phase steam-water flow generated in the boiling of water flowing in an electrically-heated tube at 1 to 4 atmospheres. The range covered was from the first formation of steam up to the so-called burn-out point, at which the surface temperature at the end of the tube rose abruptly. On increasing the heat input from zero, the liquid could be considerably superheated before any vapor was formed; when vapor nucleation finally took place, vapor growth was accompanied by characteristic instabilities. These were qualitatively elucidated using a separate glass apparatus. On further increasing the heat flux, the instabilities disappeared and a smooth transition to annular flow occurred. Measurements of the flow rate in the liquid film in annular regimes are described. Film flow approach to zero as the burn-out point is approached is also described. The loss of liquid from the film by droplet entrainment is, therefore, of critical importance in determining the burn-out heat flux. The flow rate of entrained liquid could be deduced from the film flow rate measurements, and it was shown that in the heated system, the entrainment was lower than that measured for adiabatic flow. As the burn-out point was approached, net deposition of droplets occurred towards the end of the heated section, particularly for long heated lengths. Extensive data on burn-out heat flux are also reported; these cover a range of mass velocities, pressures, and heated lengths, and two different wall thicknesses. The tubes of different wall thickness gave significantly dissimilar burn-out heat flux and film flow rate results. (auth)

41140 EXPERIMENTAL STUDIES OF BURN-OUT USING FREON 12 AT LOW PRESSURE, WITH REFERENCE TO BURN-OUT IN WATER AT HIGH PRESSURE. Staniforth, R.; Stevens, G. F. (Atomic Energy Establishment, Winfrith, Eng.). Proc. Inst. Mech. Eng. (London), 180: Pt 3C, 216-25(1965-66).

From Symposium on Boiling Heat Transfer in Steam-Generating Units and Heat Exchangers, London, Sept. 15–16, 1965. See CONF-650988.

Studies which have been made of burn-out in boiling Freon 12 flowing in round tubes are reviewed. The work was carried out at a pressure of 155 lb/in.^{2} absolute in order that the ratio of liquid density to vapor density should be the same as that for boiling water at 1000 lb/in.^{2}. The Freon data proved to be so highly repeatable that a clear, detailed pattern of the dependence of burn-out heat flux on the controlling parameters could be seen. The similarity between the Freon data and data for water at 1000 lb/in.^{2} enabled this pattern to be identified in the water data. It is doubtful whether this could have been done previously because of scatter and inadequate coverage. Studies of the relation between burn-out and liquid film flow rate along the heated wall are presented and discussed. A method is given whereby the Freon data may be related to water data by the use of scaling factors. It is hoped that a Freon rig will be useful in work on rod cluster types of test sections. (auth)

41141 BOILING IN SUB-COOLED WATER DURING FLOW UP HEATED TUBES OR ANNULI. Thom, J. R. S. (Babcock and Wilcox Ltd., Renfrew, Eng.); Walker, W. M.; Fallon, T. A.; Reising, G. F. S. Proc. Inst. Mech. Eng. (London), 180: Pt 3C, 226-46(1965-66).

From Symposium on Boiling Heat Transfer in Steam-Generating Units and Heat Exchangers, London, Sept. 15–16, 1965. See CONF-650988.

Work is described concerning the presence and extent of steam voidage and its effect on two-phase flow pressure drop and heat transfer. Empirical correlations are suggested relating the flow parameters. An investigation into the presence and extent of voidage during boiling of sub-cooled water is described. Tests were carried out at 750 and 1000 lb/in.^{2} pressures with mass velocities ranging from 470,000 to 1,150,000 lb/h ft^2 and heat fluxes 130,000 to 430,000 Btu/h ft^2. At selected cross-sections along the vertical test specimen the apparent density was measured by gamma-ray attenuation. These experimental determinations were plotted against local mixture enthalpy calculated by heat balance and the presence and extent of sub-cooled boiling made apparent. Discussions are included on the coefficient of heat transfer between the surfaces of vertical stainless steel tubes and demineralized water flowing through them whether or not accompanied by boiling. Tests were carried out at 750 to 2000 lb/in.^{2}. Investigations of liquid phase convectional heat transfer and two-phase nucleate sub-cooled boiling heat are transfer are reported. Heat flux varied from 90,000 to 500,000 Btu/h ft^2. Comparisons are made with accepted correlations and improvements are suggested. (J.R.D.)

41142 AN EXPERIMENTAL INVESTIGATION OF THE HEATING MECHANISM OF CARBON DIOXIDE ABOVE AND BELOW THE CRITICAL POINT. Daniels, T. C.; Bramall, J. W. (Univ. of Swansea, Wales). Proc. Inst. Mech. Eng. (London), 180: Pt 3C, 247-59(1965-66).

From Symposium on Boiling Heat Transfer in Steam-Generating Units and Heat Exchangers, London, Sept. 15–16, 1965. See CONF-650988.

An apparatus used to measure heat transfer in the critical region is described. Experimental data are presented and a comparison made for heating carbon dioxide both above and below the critical point. It was found that the boiling curve tended to require less surface superheat as the pressure was increased. In the super-critical region initially the heating curve tends to be very similar to the sub-critical curve, but there is a rapid convergence into a common curve. (auth)

41143 FLOW VISUALIZATION STUDIES OF BOILING AT HIGH PRESSURE. Bennett, A. W. (Atomic Energy Research Establishment, Harwell, Eng.); Hewitt, G. F.; Kearsey, H. A.; Keeys, R. K. F.; Lacey, P. M. C. Proc. Inst. Mech. Eng. (London), 180: Pt 3C, 260-70(1965-66).

From Symposium on Boiling Heat Transfer in Steam-Generating Units and Heat Exchangers, London, Sept. 15–16, 1965. See CONF-650988.

An investigation is described of flow patterns in a 0.497-ID tube for steam-water flow generated by boiling at 500 and 1000 lb/in.^{2} absolute. Two methods were used to investigate the flow patterns, namely, high-speed ciné photography of the flow emerging from

the end of the heated section into a glass tube of equal diameter, and x-ray photography through a specially designed titanium test section which formed part of the main tube and was electrically heated. The high-speed ciné technique was used to investigate a very wide range of flow conditions and led to the development of a flow pattern diagram for the two pressures considered. A new type of flow pattern (wispy annular) has been observed and is important particularly at high mass velocities. In this regime, the entrained phase flows in a segregated manner in frothy lumps. The x-ray method was able to distinguish gross discontinuities in the flow and was very helpful in interpretation of the ciné film tests. (auth)

41144 DEVELOPMENTS IN HEAT TRANSFER. Rohsenow, W. M. (ed.). Cambridge, Mass., Massachusetts Institute of Technology Press, 1964. 540p. $15.00.

Heat transfer associated with various flow situations, basic equations of continuity, energy, momentum, and mass transfer are discussed and their use in constant property boundary-layer solutions illustrated. Combined heat and mass transfer, chemical reactions, ablation and hypersonic flows are also discussed. Heat transfer associated with rarefied gases, non-Newtonian fluids, and magnetohydrodynamic effects are described. Heat transfer in liquid metals in turbulent flow is discussed. Heat transfer associated with condensation is reviewed with particular reference to condensing liquid metal vapors. Recent data are reviewed which suggests explanations for the significant discrepancies between results, analysis and experiments. Boiling heat transfer, two-phase flow phenomena, radiation in enclosures, natural convection flow in single and multiple channels, problems of graphite burnup and heat transfer, are discussed. (F.S.)

41145 HEAT TRANSFER ACROSS BAFFLED PRESSURE TUBES: CVTR. Sandberg, R. O.; Bishop, A. A. (Westinghouse Electric Corp., Pittsburgh). New York, American Society of Mechanical Engineers, 1967, Preprint No. 66-WA/NE-3, 8p., $1.50. (CONF-661102-36). DTIE.

From American Society of Mechanical Engineers, Winter Annual Conference, New York.

A thermal insulation system was designed to reduce heat losses from the coolant to the moderator in the CVTR pressure tube nuclear reactor. A series of narrow, vertical water layers was used as the insulating medium. The effective thermal resistance of the water layers was predicted analytically, and measured experimentally, both in-pile and out-of-pile. The system has now been operating successfully in the CVTR reactor for three years, and heat losses have remained virtually constant during this period at approximately 3.5 percent of the total generated power. (auth)

41146 HEAT BIBLIOGRAPHY, 1966. NATIONAL ENGINEERING LABORATORY, MINISTRY OF TECHNOLOGY (U.K.). Murray, I. (ed.). 374p. 47s. 6d.

This bibliography contains a section on heat transfer in nuclear engineering. (UK)

Isotope Technology

Refer also to abstracts 40935, 41072, 41088, 41095, and 41292.

41147 (DP-1120-1) SAVANNAH RIVER LABORATORY ISOTOPIC POWER AND HEAT SOURCES. PART I. ^{60}Co. Quarterly Progress Report, April–June 1967. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). July 1967. Contract AT(07-2)-1. 12p. Dep. CFSTI.

A total of 8.8 million curies (137 kW) of ^{60}Co was discharged from the reactors during the quarter, including over 5½ million curies as 0.745-inch-diameter by 0.040-inch-thick wafers with specific activities between 300 and 400 Ci/g. Measured diffusion profiles of ^{60}Co into encapsulating alloys showed that small but significant concentrations of ^{60}Co extend beyond the observable reaction zone. An Inconel 600 capsule containing radioactive cobalt was heated in air at 850°C for 1000 hr without significant changes in dimensions or appearance. (auth)

41148 (MMM-3824-0009) SNAP-23A PROGRAM, PHASE I. THERMOELECTRIC CONVERTER DEVELOPMENT PROGRAM. Quarterly Report No. 2, April 1, 1967–June 30, 1967. Wachenheim, J. V. (Minnesota Mining and Mfg. Co., St. Paul). Contract AT(30-1)-3824. 116p. Dep. CFSTI.

The SNAP-23A Experimental Mockup Converter design was completed. The 60-watt converter development program proceeded with the design, fabrication, and testing of components. The thermoelectric couple development program is being conducted to evaluate and improve the performance of the ten-couple module. (L.C.L.)

41149 (NASA-CR-784) AUXILIARY POWER SYSTEMS FOR A LUNAR ROVING VEHICLE. Erlanson, E. P. (General Electric Co., Philadelphia, Pa. Missile and Space Div.). Aug. 1967. Contract NAS-3-7627. 285p. CFSTI.

Five types of power systems were considered for use with a two man lunar roving vehicle for a 45-day-mission. Life support and cabin environmental control system conceptual designs were investigated. The benefits of thermal integration of the power and life support system were determined. Comparisons were made of non-integrated and integrated designs to determine the combination with the most merit. An integrated isotope Brayton cycle–life support system was selected as the one with the most potential for use with the roving vehicle. (auth)

41150 (NP-16994) APPLICATION OF LARGE RADIATION SOURCES IN ISRAEL. Foa, E.; Lapidot, M. (Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Center). [1965]. 118p. Dep.

Progress in the use of large radiation sources in Israel during 1964 to 65 is reported. Programs for the use of large sources in agriculture and industry for 1965 to 66 and a forecast for their use in 1966 to 71 are described. Technological and economic surveys were made of the use of large radiation sources for the radiopreservation of agricultural produce, fish, and meat and for industrial applications related to chemistry, plastics, wood, plywood, building materials, and hospital supplies. (F.S.)

41151 (PRNC-82) ANNUAL REPORT, 1965. (Puerto Rico Nuclear Center, [Mayaguez]). Contract AT(40-1)-1833. 225p. Dep. CFSTI.

Program accomplishments and activities in nuclear science and engineering and in the applications of nuclear energy in medicine, agriculture, and industry are reviewed. Educational and training programs, biological and medical research, physical research, and radiation preservation of tropical foodstuffs are discussed. (M.C.G.)

41152 CALIBRATION OF ^{65}Zn AND ^{54}Mn GAMMA-SPECTROMETRIC SOURCES. Bazhenov, V. A.; Bochkarev, V. V.; Golubev, Yu. M.; Ivanov, Yu. F.; Nikol'skaya, N. L.; Sokolova, T. N. Izmer. Tekh., No. 6, 70-2(June 1967). (In Russian).

Sources of ^{65}Zn and ^{54}Mn can be calibrated by direct comparison with standard sources of ^{46}Sc, which has a 0.885 MeV gamma ray comparable to 0.835 MeV gamma ray in ^{54}Mn, and a 1.119 MeV gamma ray comparable to the 1.119 MeV gamma ray of ^{65}Zn. The ^{46}Sc source can be calibrated by 4π beta-gamma coincidence counting with an error of only ±0.5% in the activity determination. On comparing count rates of the standard ^{46}Sc source with ^{65}Zn sources on a 30 × 20 mm NaI(Tl) crystal having a resolution of 8.5% for the 662 keV ^{137}Cs line, it was found that the error of determining the number of gamma quanta emitted by the ^{65}Zn source per unit time over an angle of 4π was less than 1%, which significantly exceeded the accuracy obtained by other methods. The accuracy of calibrating a ^{54}Mn source by comparison with a ^{46}Sc source was ±1.2%, but it was necessary to introduce a correction for the difference in counting efficiencies of the 0.835 and 0.885 MeV gammas of ^{54}Mn and ^{46}Sc respectively. It was also necessary to subtract the Compton scattering contribution from the 1.119 MeV gamma line of ^{46}Sc. (TTT)

41153 250 WATT RADIOISOTOPE THERMOELECTRIC POWER SUPPLY SYSTEM. Linde, Donald W. (General Electric Co., Philadelphia). pp 197-206 of Advances in Energy Conversion Engineering. New York, American Society of Mechanical Engineers, 1967.

From 2nd Intersociety Energy Conversion Engineering Conference, Miami Beach, Fla., Aug. 13–17, 1967. See CONF-670806.

The design and analysis was recently completed for a 250-W 5-yr power supply system for an earth orbiting spacecraft. Features of the design are the interchangeability of various radioisotopes for heat sources, controlled intact re-entry of the RTG and ultimate safe disposal of the radioisotope heat source by recovery or disposal in deep, relatively isolated sections of the ocean. A complementary design and analysis study was also undertaken to define the ground handling equipment required to remotely load and unload the radioisotope heat source for on-the-pad fueling operations. The ground handling equipment was fully integrated into existing launch facilities. The potential problem areas which were uncovered are discussed and tentative solutions were advanced. The power supply system was integrated into a spacecraft design during the study. The thermal, mechanical, and interface problem areas are discussed. Integration was accomplished for the controlled intact re-entry package with existing and proposed worldwide communications networks. (auth)

41154 DESIGN AND TEST OF A SNAPOODLE THERMOELECTRIC GENERATOR. Leventhal, E. Lee (TRW Systems,

Redondo Beach, Calif.); Lurie, Henry; Perkins, David R. pp 221-34 of Advances in Energy Conversion Engineering. New York, American Society of Mechanical Engineers, 1967.

From 2nd Intersociety Energy Conversion Engineering Conference, Miami Beach, Fla., Aug. 13–17, 1967. See CONF-670806.

A thermoelectric converter designed to operate with SNAP-OODLE, a hybrid radioisotope thruster/electric generator, was fabricated by RCA and tested by TRW Systems. The converter was a full-scale model of the generator, except for its length, which was reduced to one-third scale. Current-voltage curves were obtained for the converter at several power input levels, and a 1500-hr test was conducted with a hot shoe temperature of 1000°C. An initial overall conversion efficiency of 4.15% was obtained. A 7.5% reduction in power was noted during the 1500-hr test; however, a large part of that reduction can be attributed to the lack of an adequate burn in period. The rate of power decrease was sharply reduced by the time the 1500-hr test was complete. (auth)

41155 ^{60}Co AS A THERMIONIC FUEL FOR MULTI-KILOWATT APPLICATIONS. Raab, Bernard (Fairchild Hiller Corp., Farmingdale, N. Y.). pp 543-52 of Advances in Energy Conversion Engineering. New York, American Society of Mechanical Engineers, 1967.

From 2nd Intersociety Energy Conversion Engineering Conference, Miami Beach, Fla., Aug. 13–17, 1967. See CONF-670806.

The major problems confronting the use of ^{60}Co as a thermionic fuel are fuel form and package size as they relate to fuel melting point, temperature drop, and gamma-ray energy recovery ratio. It is concluded that the preferred fuel form is a cobalt-rhenium alloy, and that fuel costs per watt-electric can be substantially reduced by the transition from thermoelectric to thermionic, and ultimately to binary systems. The influence of fuel-converter configuration is explored, and is shown to strongly favor the use of an externally-fueled thermionic system. (auth)

41156 HIGH TEMPERATURE RADIOISOTOPE CAPSULE FOR LARGE HEAT SOURCE. Topper, Leonard (Atomic Energy Commission, Washington, D. C.). pp 553-61 of Advances in Energy Conversion Engineering. New York, American Society of Mechanical Engineers, 1967.

From 2nd Intersociety Energy Conversion Engineering Conference, Miami Beach, Fla., Aug. 13–17, 1967. See CONF-670806.

The AEC has initiated a program to develop the technology of an isotope fuel capsule, containing plutonium-238, and capable of operating in a space environment at a surface temperature of about 2000°F for five years or more. The capsule is a multilayered cylindrical structure which is not vented. It employs a tantalum alloy strength layer and a platinum alloy oxidation resistant outer layer; a ceramic layer prevents chemical interaction of these layers. The objectives of the capsule development program include: process and fabrication activity, required to define an acceptable manufacturing specification and to manufacture test items, and a test program to validate presently accepted design approaches and to define design margins that would actually exist for high temperature capsules intended for flight systems. The test program requires various coupons and capsules, and calls for an evaluation of chemical compatibility, thermal cycling and adherence of coatings, capsule creep, capsule impact, and capsule earth burial. The schedule for completion of this development effort by mid-1969. (auth)

41157 ISOTOPE DYNAMIC SPACE POWER SYSTEMS. Boretz, J. E. (TRW Systems, Redondo Beach, Calif.). pp 615-51 of Advances in Energy Conversion Engineering. New York, American Society of Mechanical Engineers, 1967.

From 2nd Intersociety Energy Conversion Engineering Conference, Miami Beach, Fla., Aug. 13–17, 1967. See CONF-670806.

Outlines of the Stirling, Brayton, and Rankine dynamic cycles which are compatible with the use of isotope heat sources (Polonium-210 and Plutonium-238) are presented and the advantages and disadvantages inherent in each system are discussed. The emphasis is on the use of space power systems for long-duration missions (in excess of 1 year), and low-altitude (100–300 n.mi.) earth-orbital applications. However, the study was conducted for a mission duration of approximately 400 hr with a power level of 1.5 kW. (auth)

41158 NAVY RADIOISOTOPE POWER PROGRAMS FOR TERRESTRIAL AND UNDERSEA APPLICATIONS. Hagey, Graham L. (Naval Facilities Engineering Command, Washington, D. C.). pp 771-81 of Advances in Energy Conversion Engineering. New York, American Society of Mechanical Engineers, 1967.

From 2nd Intersociety Energy Conversion Engineering Conference, Miami Beach, Fla., Aug. 13–17, 1967. See CONF-670806.

A review is presented of the on-going Navy radioisotope programs. The potentially promising future application areas for radioisotope power in terrestrial and undersea environments are indicated. The Naval Facilities Engineering Command (NAVFAC) presently has four radioisotope thermoelectric generators (RTG's) supporting Navy programs: SNAP-7C powering a weather transmitter at Brockton Station, Antarctica; a SNAP-7D powering NOMAD automatic weather station in the Gulf of Mexico; a SNAP-7E powering an underwater transmitter at the Bermuda underwater acoustic range; and a LCG-25A, powering an oceanographic telemetry system at Fairway Rock, Cape Prince of Wales, Alaska. Status and system characteristics of these generators are tabulated. The SNAP's 7C, 7D, and 7E are Atomic Energy Commission (AEC) prototype RTG's on loan to the Navy. The LCG-25A was procured from the Martin Company, and is owned by the Navy. NAVFAC is obtaining by loan and procurement 100 milliwatt(e) to 25 watt(e), strontium 90 titanate, thermoelectric generators for laboratory and undersea test, evaluation, and operational use at the Naval Civil Engineering Laboratory (NCEL), Port Hueneme, California. The Naval Air Systems Command, through coordination with NAVFAC, is procuring three radioisotope-powered (LCG-25) NOMAD weather buoys. The Naval Electronics Laboratory (NEL), San Diego, California, has requested NAVFAC assistance with the procurement of a 25 watt(e) RTG for a 1968 underwater sound propagation mission. The Naval Oceanographic Office (NAVOCEANO) has requested NAVFAC assistance in procurement and emplacement of four, 25 watt(e) RTG's for oceanographic-buoy interrogation, recording, and location system (IRLS). Additionally, a Navy Specific Operational Requirement (SOR) exists for a small (approximately 10 kilowatts(e)) radioisotope system. The kilowatt radioistope system is required for potential missions. Additional, future Navy requirements for radioisotope power are being collated by NAVFAC. (J.R.D.)

41159 TERRESTRIAL RADIOISOTOPE FUELED KILOWATT POWER SYSTEMS. Lyon, Warren C. (Hittman Associates, Inc., Baltimore); Starr, Maurice D. pp 821-8 of Advances in Energy Conversion Engineering. New York, American Society of Mechanical Engineers, 1967.

From 2nd Intersociety Energy Conversion Engineering Conference, Miami Beach, Fla., Aug. 13–17, 1967. See CONF-670806.

Discussions are presented concerning the use of radioisotopes to fuel electric power plants in the low-kW range for sea and land installations. Energy conversion techniques are compared using tabular listings. Promising fuels for these applications include ^{144}Ce (6 to 9 mo life), ^{60}Co (5 yr life), and ^{90}Sr (greater than 5 yr life). Preliminary investigations reveal that weights between 5000 and 8000 lb are to be expected. Plant costs between $500,000 and $1,000,000 are expected for 5 yr life or greater. (J.R.D.)

41160 RANDOM INTACT REENTRY AND EARTH BURIAL STUDY FOR RADIOISOTOPE THERMOELECTRIC GENERATORS. Kortier, W. E.; Ungar, E. W.; Whitacre, G. R.; Ketchman, J. J. (Battelle Memorial Inst., Columbus, Ohio). pp 981-95 of Advances in Energy Conversion Engineering. New York, American Society of Mechanical Engineers, 1967.

From 2nd Intersociety Energy Conversion Engineering Conference, Miami Beach, Fla., Aug. 13–17, 1967. See CONF-670806.

Results of investigations to determine the feasibility of random intact reentry and earth burial as a disposal for ^{90}Sr-fueled radioisotope thermoelectric generators are presented. The study results show that intact reentry and burial can be achieved without auxiliary mechanisms to transpose the heat source into a reentry vehicle. It is concluded that design radioisotope thermoelectric generators can be achieved using heat sources planned to function as reentry, impact, and earth burial bodies. (J.R.D.)

41161 INDUSTRIAL TESTS OF AN ISOTOPE BELT CONVEYOR BALANCE. Girczys, Janusz; Piatkowski, Andrzej. Rudy Metale Niezelaz., 12: 359-62(July 1967). (In Polish).

Tests were carried out with a prototype isotope belt conveyor balance based on the dependence between the intensity of the scattered γ radiation and the magnitude of the belt load. Results of tests indicate that the prototype balance could be used for weighing zinc–lead ore with an error exceeding ±5%. Conditions to be met to improve the accuracy of weighing are indicated. (auth)

41162 POTENTIAL OF LOW-POWER THERMIONIC DEVICES FOR TERRESTRIAL APPLICATIONS. Princiotta, F. T.; Bustard, T. S. (Hittman Associates Inc., Baltimore). J. Spacecraft Rockets, 4: 1086-9(Aug. 1967).

Potential terrestrial applications of isotope-fueled thermionic generators were evaluated. The following problems must be

solved prior to the realization of reliable and economic performance of these systems: the ability of the Cs diode and heat pipe (if required) to perform reliably for 5 years, development of emitters to operate at temperatures of about 1400°C, and a mode of thermal power flattening must be developed for ^{60}Co. It was concluded that development problems are substantial but no greater than the problems associated with space application. Both ^{60}Co thermionic and cascaded systems offer sufficient potential to warrant more detailed evaluation. (F.S.)

41163 THE DEPTH DISTRIBUTION OF CHARACTERISTIC X-RAYS IN X-RAY MICROANALYZER TARGET. II. TRACER METHOD. Shimizu, Ryuichi (Osaka Univ.); Miura, Makoto. Technol. Rep. Osaka Univ., 16: 415-22(Oct. 1966).

The depth distribution of x-rays was determined by the tracer method using the sandwich target of zinc and copper. The variation in the distribution for accelerating voltage was investigated by the use of different types of electron probe microanalyzers. Some investigation on the preparation of zinc evaporation was made as a preliminary experiment and it is found that preliminary evaporation of certain elements to form the nucleus is very useful for the purpose. (NSA of Japan)

41164 STUDIES ON RADIOACTIVE X- AND GAMMA-RAY SOURCES APPLIED TO THE DETERMINATION OF ASH CONTENT OF COAL. Tanemura, Takashi; Suita, Hiroshi (Rigakii Denki Co., Japan). Oyo Butsuri, 36: 444-51(June 1967). (In Japanese).

In order to find the radioactive γ- or X-ray source suitable to the determination of ash content, of coal by X-ray backscattering, various sources of energy below 60 keV were studied. Monochromatic X-rays of energy between 10 and 35 keV were supplied by γ-excited X-ray sources which consist of the ^{241}Am γ source and various target materials of atomic number in the range of 35 to 56. Commercially available sources as ^{241}Am, $^{3}H/Zr$ and ^{55}Fe were also tested. High sensitivity in the analysis was obtained with the sources of energy between 9 and 30 keV. The main difficulty of this method of analysis is that the intensity of scattered X rays is not solely due to the ash content but dependent on the composition of ash, in particular, the content of Fe_2O_3. With ^{55}Fe or the γ excited Sr K X-ray source the observed intensity of X-rays was independent of the Fe_2O_3 content. The results lead to the conclusion that an X-ray source of energy slightly below 15 keV is the most suitable for the purpose. (NSA of Japan)

41165 IMPROVEMENTS IN AND RELATING TO THE MEASUREMENT OF MATERIAL ON A CONVEYOR. (to Ohmart Corp.,) British Patent 1,078,831. Aug. 9, 1967. Priority date July 29, 1963, United States.

A measurement system is described which is used in measuring the weight of solid materials as they are delivered on a conveyor. The system consists of an elongated radiation source and detector which extend horizontally in a transverse direction to the conveyor. Radiations emitted from the source pass through the conveyor and the material carried on the conveyor and then impinge on the detector. The detector produces a current flow correlated with the weight of material per unit length of the conveyor. (F.S.)

41166 ZINC SULPHIDE PHOSPHORS. (to Nippon Electric Co., Ltd.). British Patent 1,083,018. Sept. 13, 1967. Priority date Mar. 25, 1965, Japan.

The manufacture of a zinc sulfide phosphor which emits a yellow or greenish yellow color of high visibility to the human eye and higher brightness than conventional zinc sulfide phosphors is described. The phosphor can be produced without the use of a special reducing atmosphere. The phosphor is manufactured by incorporating lead and phosphorus in zinc sulfide by diffusion at a temperature of 800°C or in a vacuum sealed container at temperatures of from 1050 to 1200°C. (F.S.)

41167 ARRANGEMENT FOR TREATING MATERIAL WITH RADIATION FROM A RADIOACTIVE beta-SOURCE. (to Osterreichische Studiengesellschaft Fur Atomenergie GmbH.). British Patent 1,083,464. Sept. 13, 1967. Priority date Nov. 28, 1963, Austria.

A method and arrangement are described for irradiating gaseous, liquid, and solid materials with a β-source. Layers of thin plates of radioactive materials are arranged to surround or to almost surround the material to be irradiated, the smallest distance between two plates being not more than the range of the β-radiation in the material to be irradiated. (F.S.)

Materials Testing

Refer also to abstracts 41095 and 42863.

41168 (UCRL-70178) FLASH RADIOGRAPHY OF EXPLODING SYSTEMS. Bahl, Kerry L. (California Univ., Livermore. Lawrence Radiation Lab.). May 22, 1967. Contract W-7405-eng-48. 9p. (CONF-671002-1). Dep. CFSTI.

From 27th National Fall Conference of the Society for Nondestructive Testing, Cleveland, Ohio.

High-current generators that produce short, intense pulses of x rays enabled experimenters to develop highly specialized techniques for the radiography of high-speed phenomena associated with the detonation of chemical high explosives. These radiographs, in turn, yielded enlightening information about the hydrodynamic behavior of materials at very high pressures. Some fundamentals of flash x-ray radiography, characteristics of flash x-ray generators, and general radiographic techniques as applied to exploding subjects are discussed. (M.C.G.)

41169 (ORNL-tr-1780) EARLY DEVELOPMENTS OF NEUTRON RADIOGRAPHY IN FRANCE. Barton, J. P.; Boutaine, J. L. Translated by Martha Gerrard (Oak Ridge National Lab., Tenn.), from Bull. Inform. Appl. Ind. Radioelem., No. 66, 4-9(1967). 11p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

The development of a technique using neutrons for radiography has been going on in France for two years, and the procedures are being routinely applied and undergoing long-term studies in several laboratories. Some simple aspects of the technique, in particular the use of a collimated thermal-neutron beam from a nuclear reactor, may be a good method for examination and as a basis for application in various fields of industry. Advantages of neutron radiography compared with x radiography are discussed. (M.C.G.)

41170 EXAMINATION OF THE HOMOGENEITY OF CONCRETE STRUCTURES IN A NUCLEAR POWER STATION. Honig, Arnost; Zapletal, Vratislav (Technical Univ., Brno). Inzenyrske Stavby, No. 4, 145-53(1966). (In Czech).

The necessity of examining the homogenity of concrete in nuclear reactor shielding prior to operation is discussed, including the use of radiometry and ultrasonic tests. The latter method, which is based on measuring the passage of ultrasound, was chosen to examine the concrete shielding of the reactor in the Czechoslovakian Nuclear Power Station A 1. Reasons for not using the ultrasound reflection method are given. Measurements of ultrasonic-wave propagation through the concrete wall and of the wall thickness are described. Results are presented in graphs and tables of the characteristics of the concrete and the dependence of the ultrasonic velocity upon density are given for regular (2200 kg/m^3) and heavy (3600 kg/m^3) concrete. Relationships between attenuation of gamma radiation, the ultrasonic pulse velocity, and the concrete density are also given. Authors conclude that a comparatively good homogeneity of the concrete structures was found, except for a few isolated spots. Injections to increase the density are under consideration. (ATD)

41171 NONDESTRUCTIVE TESTING OF BRAZED JOINTS. Kanno, Akira (Ship Research Inst., Tokyo). Senpaku Gijutsu Kenkyujo, No. 8, 1-23(Nov. 1965).

The nondestructive testing of brazed joints was studied. The base metal used was ASTM 304 stainless steel. Brazing alloys containing thermal neutron-sensitive elements (boron, silver, cadmium, etc.) were chosen. As standard brazing faults, the brazing alloy foils which varied in thickness from 0.0127 to 0.0762, containing various holes, were sandwiched between the base metals which varied in thickness from 1.59 to 6.35 mm. The specimens were tested by neutron radiography, indium transfer neutron radiography, and X-radiography. The diameter and width of brazed joint faults were compared by means of the hole-type radiographic penetrometer; the relation between the hole diameter and width was in accordance with Criscuolo's equation for the thickness between 0.0254 to 0.0762 mm in X-ray radiography, in the In transfer method. The neutron radiography showed excellent detection when used on the Easy Flow brazing alloy. The In transfer method gave results comparable with X-radiographs for detection of the Easy Flow faults. Both the neutron methods gave poor results for foils which contained no neutron-sensitive elements except silver. The ultrasonic methods are advantageous in detecting nonbonds in diffusion-bonded samples, not replaceable by radiography. However, small faults of about 1.6 mm diameter cannot be shown clearly in 12.7 mm-thick specimens, especially near the edges. For the faults, the neutron radiography method is recommended for thermal neutron-sensitive brazing alloys. (NSA of Japan)

41172 DIVERGENT BEAM COLLIMATOR FOR NEUTRON RADIOGRAPHY. Barton, J. P. (CEN, Grenoble, France). Mater. Eval., 25: 45A-6(Sept. 1967).

In neutron radiography, the collimation system has an important influence on the capabilities of the technique. It is pointed out that

the function of the collimator need not necessarily be to render the neutron beam parallel: a divergent collimator may be used. Such a divergent system can provide the same radiographic speed, sharpness and field size as a parallel, multi-channel collimator. Four possible advantages of the system are listed. (auth)

41173 AN ULTRASONIC IMAGING LAMB-WAVE SYSTEM FOR REACTOR FUEL PLATE INSPECTION. Berger, H. (Argonne National Lab., Ill.). Ultrasonics, 5: 39-41(Jan. 1967).

An ultrasonic television system with a Lamb-wave technique for the inspection of flat reactor fuel plates is described. The system offers good resolution, high inspection speed and good sensitivity to the discontinuities of interest. A combined inspection system, in which a preliminary test would be made with this system and a final test of suspect items made with a mechanically scanned system, could make good use of the advantages of both systems. (UK)

41174 A QUANTIZED EDDYFAX TECHNIQUE APPLIED TO THE INSPECTION OF REACTOR GRADE GRAPHITE. Sharpe, R. S. (Atomic Energy Research Establishment, Harwell, Eng.); Hodgkinson, W. L.; Aveyard, S. Brit. J. Non-Destruct. Test., 9: 80-5(Sept. 1967).

Studies are described showing how the Eddyfax eddy current technique developed at A.E.R.E., Harwell, can considerably improve flaw discrimination when applied to graphite. The technique has provided a satisfactory production inspection procedure for graphite components for the Dragon reactor. A description is given of the inspection technique, including improvement of its selectivity by processing the variations in oscillator amplitude using a quantizer, which converts the signal into a stepped series of voltages each of which can be identified on the recorder trace as a discrete writing shade. (UK)

41175 EXTREMES IN ENVIRONMENTAL TESTING. Schwanbeck, Carl A.; Jamison, Roy E. (Lockheed-Georgia Co., Marietta). Lockheed Ga. Quart., 4: No. 2, 23-7(Aug. 1967).

An investigation of the suitability of aerospace materials for use in cislunar and deep space is described. The nature of simple cryogenics, combined nuclear-cryogenic environmental effects, and the effects of post-irradiation annealing of certain aluminum and titanium alloys were discussed. Tensile tests were conducted after specimen irradiation on thirteen aluminum alloys. Tensile tests were performed on several titanium alloys after being subjected to neutron irradiation. Other tests were conducted to determine the effects of fast neutron irradiation temperature on certain mechanical properties of aerospace materials. An increase in turbulence of plastic flow caused by neutron induced lattice imperfections was noted. (F.S.)

41176 IMPROVEMENTS IN OR RELATING TO APPARATUS FOR EXAMINING THE INTERNAL STRUCTURE OF A BODY. Hodgkinson, William Lloyd (to United Kingdom Atomic Energy Authority). British Patent 1,083,501. Sept. 13, 1967. Filed Mar. 11, 1964.

An apparatus for examining the internal structure of a body such as a fuel element in a nuclear reactor is described. Means are provided to derive an electric signal which varies depending upon variations in characteristics of the internal structure of the body. The signal, supplied to a recorder, produces a pictorial representation of the variations in characteristics. The signal, which may be from γ or β particles, γ or x-rays, or ultrasound, will vary in proportion to the radiation originating from the body itself or from eddy currents set up in the body. (F.S.)

Protective Structures

41177 (ABS-THH-1026) ANLEITUNG ZUM GEBRAUCH DER BEI DER ARBEITSGRUPPE FUER BAUTECHNISCHEN STRAHLENSCHUTZ ZUR VERFLUEGUNG STEHENDEN RECHENPROGRAMME. II. BERECHNUNG VON ABSCHIRMKONSTANTEN (H9). (Introduction in the Use of a Calculation Program Originated for the Use of the Work Group for Technical Building Radiation Protection. II. Calculation of Shielding Constants (H9)). Sasse, S. (Technische Hochschule, Hanover (West Germany). Arbeitsgruppe fuer Bautechnischen Strahlenschutz). Dec. 1965. 32p. (In German). Dep.

The formulas for the calculation of the characteristic value of a composition material from the characteristic values of the elements are compiled. The program (H9) prepared in the program language ACT I is described. A brief description is given of the program and examples for its utilization are reported. (J.S.R.)

41178 (AD-645617) ORGANIZATION FOR RADIOLOGICAL SURVEY, 1965-1970. (Army Combat Developments Command, Fort McClellan, Ala. Chemical-Biological-Radiological Agency). Mar. 1965. 69p. CFSTI.

The organizational and operational concepts of radiological survey in Army divisions are reviewed in order to determine what changes are necessary in the 1965 to 1970 time frame in light of ROAD-65. The relative merits of aerial and ground radiological survey methods are investigated from standpoints of accuracy, reponsiveness, and equipment. The impact of developmental radiac equipment on organizational and operational concepts for survey is analyzed. The manning level of the division CBRE and communications required to support radiological survey are investigated. Distribution of radiac survey instruments in DA-approved ROAD TOE's is reviewed for adequacy and changes are suggested as appropriate. (auth) (TAB)

41179 (AD-645908) SCATTERING OF FALLOUT RADIATION FROM CEILINGS OF PROTECTIVE STRUCTURES. Special Report. Kimel, W. R.; Faw, R. E.; Baran, J. A.; Mingle, J. O.; Rubin, R. M. (Kansas Engineering Experiment Station, Manhattan). July 1966. Contract OCD-OS-63-74. 176p. (SR-72).

A thorough study of the ceiling shine problem was made. Ceiling shine is defined as that contribution to the radiation dose rate in a protective structure resulting from fallout radiation entering the structure through apertures in vertical walls and scattering downward from the ceiling. A systematic analytical analysis of this problem, verified experimentally, resulted in a set of design curves. These curves yield the ceiling shine reduction factor in any concrete structure as a function of building dimensions, size and location of apertures, and detector location. (auth) (TAB)

41180 (AD-647006) STUDY OF THE RESPONSE OF BACKPACKING MATERIAL ENCASING A TUNNEL LINER SUBJECTED TO A DYNAMIC DISTURBANCE. Nosseir, Salah; Perry, Ervin S.; Thompson, J. Neils (Texas Univ., Austin. Structural Mechanics Research Lab.). Dec. 1966. Contract DA-22-079-eng-393. 67p. CFSTI.

Deformation behavior is presented for a crushable backpacking material (flat-top stress-strain behavior) encasing a cylindrical tunnel liner, when the surrounding media are subjected to a dynamic disturbance. A mathematical model consisting of a two-degree-of-freedom lumped mass system which approximates the behavior of a tunnel liner backpacking system is used for the analysis. The resistance of the backpacking material is represented by bilinear springs. The differential equations used in representing the motions of the system are presented. An analog computer was used to determine the response of the system. Design-aid curves are presented to help a designer choose the most desirable parameters for the backpacking material for certain design conditions. The main variables in the study were: crushing strength of the backpacking material, mass of the liner, amplitude of disturbing displacement function, and, duration of the disturbing displacement function. (auth) (TAB)

41181 (AD-648870) RESEARCH DATA FROM SHELTER OCCUPANCY EXERCISES. Final Report. Collins, Robert A.; Bend, Emil (American Institutes for Research, Pittsburgh, Pa.). Dec. 1966. Contract OCD-OS-63-97. 143p. (AIR-D66-12/66-FR). CFSTI.

Data from Civil Defense University Extension Program (CDUEP) school exercises were collected and analyzed. As initially defined, the data were to include: information related to experimental manipulations, where introduced into the exercises, background information on participating students, and other data related to the occupancy exercises (supplies and equipment, general feelings about the experience, and management data). Two data collection instruments were developed, both self-administering; one for the students and one for the instructor of the course. Procedures were developed for coding this data and entering codes onto punched IBM cards for later transference to magnetic tape for purposes of ultimate storage and analysis. Marginal distributions for student and instructor questionnaire data are exhibited in table form and discussed. Selected cross tabulations are exhibited and discussed. Suggested ideas for future research are listed. (auth) (TAB)

41182 (LAMBDA-3(Vol.1)) AN OPTIMIZATION STUDY OF BLAST SHELTER DEPLOYMENT. VOLUME I, SUMMARY REPORT. Mitchell, David L. (Lambda Corp., Arlington, Va.). Sept. 1, 1966. Contract OCD-PS-66-113; Subcontract 138-5. 106p. CFSTI.

Methods of determining blast shelter deployments and of assessing their performance for a variety of nuclear attacks were examined. Stabilized deployments, which protect the population almost as well as optimal deployment, even though it is not truly optimal for any specified attack are preferred. The study examines the attacker's freedom to vary force level, time of attack, attack objective, height of burst, and targeting. A computer model, BLAST, is described which generates shelter deploymnets for the U.S. and computes their effectiveness against attacks in which

these factors are varied. The methodology, results, and conclusions are summarized. (L.C.L.)

41183 (LAMBDA-3(Vol.2)) AN OPTIMIZATION STUDY OF BLAST SHELTER DEPLOYMENT. VOLUME II. APPENDICES A-G. Mitchell, David L. (Lambda Corp., Arlington, Va.). Sept. 1, 1966. Contract OCD-PS-66-113; Subcontract 138-5. 115p. CFSTI.

Methods of determining blast shelter deployments and of assessing their performance for a variety of nuclear attacks were examined. Stabilized deployments which protect the population almost as well as an optimal deployment, even though it is not truly optimal for any specified attack are preferred. The study examines the attacker's freedom to vary force level, time of attack, attack objective, height of burst, and targeting. A computer model BLAST generates shelter deployments for the U.S. and computes their effectiveness against attacks in which these factors are varied. Seven technical appendixes, including the data employed, are presented. (L.C.L.)

41184 (LAMBDA-3(Vol.3)) AN OPTIMIZATION STUDY OF BLAST SHELTER DEPLOYMENT. VOLUME III. APPENDIX H. BLAST: THE COMPUTER PROGRAM. Mitchell, David L. (Lambda Corp., Arlington, Va.). Sept. 1, 1966. Contract OCD-PS-66-113; Subcontract 138-5. 138p. CFSTI.

Methods of determining blast shelter deployments and of assessing their performance for a variety of nuclear attacks were examined. Stabilized deployments which protect the population almost as well as an optimal deployment, even though it is not truly optimal for any specified attack is preferred. The study examines the attacker's freedom to vary force level, time of attack, attack objective, height of burst, and targeting. A computer model BLAST generates shelter deployments for the U.S. and computes their effectiveness against attacks in which these factors are varied. BLAST is described in detail for the analyst and programmer. (L.C.L.)

Radioactive Material Handling

Refer also to abstract 41027.

41185 (BMwF-FBK-67-62) THEORETISCHE UNTERSUCHUNGEN ZUR AENDERUNG DES GEOTHERMISCHEN FELDES BEI DER EINLAGERUNG RADIOAKTIVER ABFAELLE IM SALZGEBIRGE. (Theoretical Investigations on Temperature Rises in Salt Deposits Due to Underground Storage of Radioactive Waste). Mufti, I. (Bundesanstalt fuer Bodenforschung, Hanover (West Germany)). July 1967. 99p. (In German). Dep.

The subsurface disposal of high-level radioactive wastes results in a temperature rise inside the waste as well as in the surrounding rocks. A theoretical treatment of the problem shows that the deep disposal of the waste in relatively large volumes leads to very high temperatures. For calculating the temperature rise, certain diagrams are presented. These diagrams being based on dimensionless parameters have a wide applicability and cover a broad range of values of thermal constants and sizes of the disposal cavities. Moreover they can be utilized for wastes of arbitrary radioactive composition. (auth)

41186 (BNWL-453) RESEARCH AND DEVELOPMENT IN ENVIRONMENTAL SCIENCES AND RESOURCES MANAGEMENT. Pearce, D. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 1967. Contract AT(45-1)-1830. 104p. Dep. CFSTI.

The work of Battelle-Northwest, Hanford, Washington, specifically, its principal accomplishments, capabilities, and facilities in environmental sciences is described. The laboratories were established to study the interaction of radiation with materials of any kind, and have been concerned with the composition of radioactive wastes, mechanisms of distribution in the environment (including air, water, and underground), and the behavior and significance of radioactive materials in the environment. The environmental studies undertaken are categorized, and the work of each group described. An extensive bibliography of related research is provided. (L.C.L.)

41187 (DP-1093) REMOVAL OF SLUDGE FROM HIGH ACTIVITY WASTE TANKS. Hill, Arthur J. Jr. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). July 1967. Contract AT(07-2)-1. 27p. Dep. CFSTI.

Aqueous radioactive wastes from the separations processes at the Savannah River Plant are stored underground in large, carbon steel tanks, and cooled by water flowing through a network of vertical and horizontal cooling coils. To conserve space, the supernatant solutions are removed periodically from the tanks, concentrated by evaporation, and transferred to other tanks for long-term storage. During storage of the wastes prior to concentration, precipitated sludge accumulates in the bottom of the tanks. Equipment and techniques that have been developed for removal of sludge from waste tanks are described. High velocity jets of water are used to disperse the sludge into a slurry that can be removed with centrifugal pumps. The development program culminated in removal of sludge from two waste tanks. The second test, incorporating the results of experience gained in the first, was the more successful; greater than 95% of a 1.5-foot layer of sludge was removed during five hours of operation. (auth)

41188 STORAGE OF RADIOACTIVE MATERIAL. Platow, G. (Staaliche Zentrale fuer Strahlenschutz, Mueggiseedamm, Ger.). Isotopenpraxis, 3: 112-14(Mar. 1967). (In German).

The legal requirements on the construction and equipping of storage sites are given. The regulations on the storage of open and sealed radioactive sources were summarized. The responsible authority for the storage of radioactive materials is indicated. (J.S.R.)

41189 DRY STORAGE OF IRRADIATED FUEL. Lawson, D. (English Electric Co., Ltd., Whetstone, Eng.). Nucl. Eng., 12: 604-5(Aug. 1967).

Intermediate storage of fuel is required for 100 days prior to transport, and for a 1000 MW(e) Magnox station this implies a capacity of 97 Te and for a 1000 MW(e) AGR 53 Te. The use of dry stores as an alternative to ponds is discussed, and the position in regard to AGRs, in which fuel temperatures are too high for immediate discharge into water, is considered. The design of the Wylfa dry store is described. (UK)

41190 STEADY-STATE MEASUREMENT OF ^{85}Kr-AIR DIFFUSION COEFFICIENTS IN POROUS MEDIA. Reist, Parker C. (Harvard School of Public Health, Boston). Environ. Sci. Technol., 1: 566-9(July 1967).

A "diffusion cell" was designed and used to measure diffusion coefficients of Kr-air mixtures under various conditions of porosity and moisture content for evaluation of porous underground formations for the retention and disposal of waste ^{85}Kr. Results represent to a good approximation the actual diffusion coefficient of air-^{85}Kr in porous media. Since gross air flows through the sample were maintained at least below 0.15 cc/sec, measurement errors due to pressure difference across the sample were at most less than 10% of the true value of the diffusion coefficient. It was found that the addition of moisture to a porous media greatly increases its ability to retain or retard gases trapped within it. (F.S.)

41191 DISPOSAL OF RADIOACTIVE WASTES BY HYDRAULIC FRACTURING. PART IV. CHEMICAL DEVELOPMENT OF WASTE-CEMENT MIXES. Tamura, Tsuneo (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Nucl. Eng. Design, 5: 477-85(July 1967). (ORNL-P-3002).

The shale fracturing program has been concerned with the development of a technique for the safe and economic disposal of large batches of radioactive liquid wastes by mixing the waste with cement and other additives, and injecting the slurry into bedded shale at depths of about 1000 ft. Mixes suitable for use with ORNL's intermediate-level liquid waste have been developed. The slurries remain pumpable for the time (hr) required to complete an injection and once in place in the disposal formation, set into a solid matrix that fixes the principal radionuclides. These mixes have a cement base with clays added to enhance the fixation of radiocesium and a pozzolan cement system to retain the radiostrontium. (auth)

41192 SOLIDIFICATION OF RADIOACTIVE CONCENTRATES IN GLASSES OR CERAMICS. PART 1. SURVEY OF THE PAPERS PUBLISHED TILL 1965. Sachse, G.; Rosenberger, H. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger. Institut fuer Angewandte Mineralogie, Dresden). Kernenergie, 10: 205-10(July 1967). (In German).

Research in the field of safe storage of high-level radioactive concentrates by melting into glasses or ceramic materials is described. The accessible report literature as well as the results of the Conference on the Treatment and Storage of High-Level Radioactive Wastes (Vienna, 1963) and the 3rd Conference on the Peaceful Uses of Atomic Energy (Geneva, 1964) were taken into consideration. Subjects covered include: naturally occurring mineral raw materials, investigations on glass systems, technological studies, problems of the storage of vitrified high-level radioactive materials, and cost of the processes. (tr-auth)

41193 METHOD OF DETERMINING THE CONTAMINABILITY AND DECONTAMINABILITY OF MATERIALS USED IN NUCLEAR ENGINEERING. Rotrekl, B. (Forschungsinstitut fuer Synthetische Harze und Lacke, Pardubice, Czech). Kernenergie, 10: 211-14(July 1967). (In German).

A new method is described for determining the contaminability and decontaminability of paints. Reproducible and comparable results were obtained using the drop technique of deposition and a new equipment for rinsing the contaminating solutions. (tr-auth)

Vacuum Engineering

41194 ELECTROSTATIC GETTER-ION-PUMP DESIGN. **Bills, Daniel G. (Granville-Phillips Co., Boulder, Colo.). J. Vac. Sci. Technol., 4: 149-55(July-Aug. 1967).**

The theory and design of a nonmagnetic, multicelled, triode, getter-ion pump capable of attaining pressures of less than 3×10^{-11} torr and a pumping speed for air of 1700 liter/sec using a 6-in.-diam orifice is described. A quantitative theory is presented for maximizing the ionizing efficiency of electrons trapped in the electrostatic potential of a cylindrical diode. The experimentally verified theory predicts that for optimum results, electrons must be injected in a well-defined range of angular momenta from an injector whose potential is nearly that of the outer cylindrical electrode. The theory also predicts the optimum axial and radial position for injection. In the new pump, each cell consists of an open cylindrical grid within which is a central anode and two electron injectors. All cells are surrounded by a common cathode which also serves as the pump housing. A new-design, large-area, resistance-heated sublimator with pressure-controlled sublimation rate is located on the axis of the cylindrical cathode. Because the ionizing and gettering functions have been effectively separated it has been possible to optimize each function separately. (auth)

41195 INITIAL ION-ENERGY DISTRIBUTION AND THE MEASUREMENT OF VERY LOW PRESSURE. II. **Comsa, George (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 12: 63-8(1967).**

Defective ion collection and the pressure limits of the Bayard-Alpert gauge were studied. Information was obtained on ion-energy distribution in high and ultrahigh vacuum. The influence of initial velocities of energetic ions on pressure measurements in high vacuum was also studied. (J.G.B.)

41196 MECHANISM OF THE ARGON INSTABILITY OF THE GETTER ION PUMP. **Sugita, Toshio; Kawasaki, Koji (Electrotechnical Lab., Tokyo). Oyo Butsuri, 36: 352-8(May 1967). (In Japanese).**

Getter ion pumps with various types of anode cells exhibit spontaneous periodic pressure fluctuations (argon instability) in the clean up of argon, krypton, and xenon. In order to obtain further information on the mechanism of this argon instability, the locations of inert gases collected by the electrodes of the pump at various phases of the pressure fluctuations was determined by using the radioactive tracer ^{131m}Xe, and the depth of erosion in the cathode is measured by means of a multiple-beam interferometer. From these experiments was found that the argon instability results from inert gases, which are released from strongly eroded regions being cleaned up at weakly eroded region. The mechanism of argon instability is discussed from the viewpoints of the penetration of ions in metals and the sputtering of metals by ion bombardment. (NSA of Japan)

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstracts 40959, 41060, 42159, 42173, 42275–42277, and 42813.

41197 (AD–644896) ANTICOINCIDENCE-SHIELDED GAMMA-RAY SPECTROMETER DATA-PROCESSING PROGRAM, REVISED. Evans, Albert E.; Durkin, James; Knadler, Charles (Naval Ordnance Lab., White Oak, Md.). Oct. 6, 1966. 39p. (NOLTR–66–195). CFSTI.

A program is described which processes and plots data accumulated by an anticoincidence-shielded scintillation spectrometer. This program is similar to that described in AD-611198, except that an error in some statistical uncertainty calculations has been corrected, provision has been made for the subtraction of a common background spectrum from a number of input spectra submitted at one time but as separate problems, and spectra are all plotted with a common energy scale to permit the accumulation of a library of easily usable standard spectra. Also, the plotting routine has been changed so that for each energy channel the number of counts and the uncertainty thereof are represented by a datum point and uncertainty bar rather than by three data points. Provision has also been made for automatic labeling of all graphs and for labeling of the vertical axes. (auth) (TAB)

41198 (AD–645283) MACHINE CODE FOR THE UNFOLDING OF PULSE-HEIGHT SPECTRA. Memorandum Report. Bock, Juergen K.; Lanahan, John V. (Ballistic Research Labs., Aberdeen Proving Ground, Md.). Sept. 1966. 99p. (BRL-MR–1790). CFSTI.

A FORAST machine code was developed for the unfolding of gamma and neutron pulse height spectra measured by means of a stilbene crystal at two different electronic gain settings. The code utilizes spectrum stripping routines based on logical decisions, is self-adapting to the input data, and requires little machine time on the high-speed digital computer BRLESC. (auth) (TAB)

41199 (AED-C–06-17) BIBLIOGRAPHIEN ZUR KERNFORSCHUNG UND KERNTECHNIK. SEKTION 06. MESSINSTRUMENTE UND MESSVERFAHREN IN DER KERNPHYSIK. (Bibliographies in Nuclear Science and Technology. Section 06. Instruments and Measuring Techniques in Nuclear Physics). Debertin, K. (comp.) (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). May 1967. 103p. (In German and English). Dep.

The titles of 375 articles appearing in Vol. 20, Nos. 1–8 of NSA on instruments and measuring techniques in nuclear physics are compiled. (W.H.K.)

41200 (BMwF-FBK–67-66) GAMMASPEKTROMETRIE MIT GERMANIUMDETEKTOREN UND MESSUNGEN AN ^{214}Po UND ^{208}Pb. (Gamma-Ray Spectrometry with Ge(Li) Detectors and Measurements at ^{214}Po and ^{208}Pb). Buschmann, H. T. (Cologne Univ. (West Germany). Institut fuer Kernphysik). Aug. 1967. 51p. (In German). Dep.

A high-resolution gamma-ray spectrometer with a Ge(Li)-detector is described. The spectrometer is used as a single crystal spectrometer as well as a three crystal pair spectrometer with a Ge(Li) central detector and two NaI-crystals for the detection of the annihilation quanta. Measurements were made at ^{214}Po. The sources were ^{222}Rn in small glass tubes, 66 different gamma-rays, 10 of which were hitherto unknown, were observed. The gamma spectrum above 2.5 MeV could well be resolved. An improved level scheme of ^{214}Po is suggested. Moreover the gamma-ray spectrum of ^{208}Pb was remeasured. The sources consisted of ^{208}Tl, electrostatically collected as recoil nuclei from ^{212}Pb sources. 20 gamma-rays were found, 7 of which were hitherto unknown. An extended level scheme for ^{208}Pb is discussed. (auth)

41201 (BNWL–508) PORTABLE GAMMA SPECTROMETER FOR SAFEGUARDS USE. Sheen, E. M.; Forsberg, J. I.; Ratcliffe, C. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sept. 1967. Contract AT(45-1)-1830. 66p. Dep. CFSTI.

A compact, portable gamma spectrometer was developed for use by the USAEC Division of International Affairs in safeguarding inventories of ^{235}U contained in nuclear reactor unirradiated fuel elements or in various other sources. General purpose gamma spectrometry is also conveniently carried out using the instrument. Main chassis solid state circuitry, excluding the scintillation probe and preamplifier, comprises a wide-range high voltage supply, double delay line pulse amplifier, split-window gain stabilizer, single channel pulse height analyzer, six decade scaler, automatic timer, count rate meter, low voltage regulators, and a battery charger. Instrument power is supplied by a NiCd rechargeable battery, also located in the main chassis, which provides a maximum of 25 hr continuous operation. All electronic circuits, except the battery charger, are fabricated in plug-in modules. The modular electronics, probe, and probe stand are mounted in two rugged compact fiberglass transit cases. (auth)

41202 (CERN–67-17) CHARGE TRANSPORT FROM TARGETS IN PROTON BEAMS, AS A MEANS OF MONITORING. Budal, K. (European Organization for Nuclear Research, Geneva (Switzerland)). July 11, 1967. 104p. Dep.

An experimental and theoretical investigation of the charge transport from targets and plates exposed to proton beams is presented. The experimental measurements concern linearity, saturation and reproducibility tests, and investigations of the parameters influencing the signal level. The theoretical treatment mainly concerns the computation of escape probabilities of knockon electrons as a function of the various parameters. Experimental and theoretical results are compared. (W.H.K.)

41203 (COO–1112-98) SOME DATA ON DIFFRACTION PEAK PROFILES AND CRYSTAL REFLECTIVITY FOR A 2-METER CURVED-CRYSTAL SPECTROMETER WITH A Ge(022) CRYSTAL. Baer, H. W.; Reidy, J. J.; Wiedenbeck, M. L. (Michigan Univ., Ann Arbor). [1965]. Contract AT(11-1)-1112. 10p. Dep. CFSTI.

Data on the diffraction properties of a curved-germanium (022) crystal used in a gamma spectrometer are presented. Line shapes, focal aberrations, and crystal reflectivity are discussed. (W.H.K.)

41204 (EUR–3567.f) LES COLLECTRONS: MESURE EN CONTINU DES FLUX DE NEUTRONS THERMIQUES. (Collectrons: Continuous Measurement of Thermal Neutron Fluxes). Grin, M. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). May 12, 1967. 52p. (In French). Dep.

Collectrons are self-powered detectors by means of which snap measurements of neutron fluxes can be effected. They consist of a sensitive component, a short-period beta emitter, and a sheath or collector. When the circuit is closed on to an appropriate gauge, a current proportional to the neutron flux can be measured. Certain principles of physics concerning neutron fluxes, cross-sections, and beta radioactivity phenomena, and the chief problems involved in collectron technology, wiring, and measuring methods are discussed. A theoretical section, containing all the physical data on the principal types of detector used (silver, rhodium and vanadium), gives the calculation of the current produced and the principal correction formulas by which allowance is made for the neutron shielding and flux depression and the beta absorption in the detector. (auth)

41205 ROTOR FOR STUDYING NEUTRON ENERGY SPECTRUM. Engineer, 224: 321-2 (Sept. 8, 1967).

The rotor, of which the design and fabrication are described, is 30 in. long by 8.3 in. diameter and carries 300 blades of Nichrome V set on a Dural shaft in grooves having a helix angle of 3°49′ relative to the axis. The speed is variable between 300 and 3,600 rpm. The design gives a transmission of 80% and a 5% resolution. (UK)

41206 STREAMER CHAMBER. Yount, David. Sci. Amer., 217: No. 4, 39-46 (Oct. 1967).

The design and use of the streamer chamber, which is essentially a modified spark chamber, is described. An extremely short high-voltage pulse is triggered by the particle which produces localized sparks along the path of the particle in an inert gas. The experiments in which this particle detector is used at the two-mile Stanford linear accelerator are briefly outlined. (W.H.K.)

41207 DELAY COMPONENT IN GAMMA SCINTILLATIONS OF THE CsI–Tl CRYSTAL. Berzin', B. Ya; Berzina, B. (Inst. of Physics, Academy of Sciences, Latvain SSR). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 3, 15-8 (1966). (In Russian).

According to the literature, the decay component of gamma-scintillations at room temperatures is characterized by different decay times. The dependence of the decay component of gamma-scintillations upon the activator Tl, or on some other luminescent centers in the CsI-Tl crystal, is investigated. The CsI-Tl crystals with the real concentrations of 0.14; 0.5; 0.7; 2.9; 6.15×10^{-2} mol%

and the nonactivated CsI crystal are examined. The method of studying the luminescence kinetics of these crystals is used. The studies were conducted during gamma-excitation as well as during photo-excitation in the temperature range from 210 to 300°K. The photoscintillations were activated through a monochromator with a quartz prism by short flashes ($\sim 10^{-7}$ sec) of a high-voltage spark. The luminescence pulses through light filters and were recorded by a photomultiplier, and the gamma-scintillations by photomultipliers. Single gamma- and photo-scintillations were obtained on a two-beam speed oscillograph. It is found that the centers responsible for luminescence with a delay time of 8 μsec are observed in the CsI-Tl crystal as well as in the CsI crystal and, consequently, are not the centers of the Tl activator. The nature of these centers was not established conclusively. It is, therefore, desirable to have detailed investigations made of luminescence centers responsible for the 8-μsec emission components in order to regulate as much as possible their presence in scintillation crystals. (ATD)

41208 LARGE HYDROGEN BUBBLE CHAMBER. CERN Cour., 7: 143-7(Aug. 1967).

A description of the large hydrogen bubble chamber for the CERN proton synchrotron is given. Bubble chamber development is briefly reviewed. The design of the proposed large bubble chamber is presented including the hydrogen chamber itself, the superconducting magnet, the expansion system, the optics, installation, and the construction program. (J.F.P.)

41209 NUCLEAR EMULSIONS FOR ELECTRON AUTORADIOGRAPHY. Ryabova, R. V.; Samoilovich, D. M.; Senchenkov, E. P.; Chentsov, Yu. S. Zh. Nauch. Prikl. Fotogr. Kinemotogr., 12: 217-18(May-June 1967). (In Russian).

Structures on the order of 10 to 20 Å can be resolved by the electron microscope, but the resolution of the better known photographic emulsions is much less (from 0.08 to 0.15 μ). The dimensions of the silver halide microcrystals in these emulsions significantly exceed the dimensions of the biological structures under investigation, and limit the accuracy of autoradiographic studies. A desirable microcrystal size would be ~200 to 300 Å. Emulsification was carried out in gelatin on glass. The gelatin was removed by centrifuging the diluted gelatin solution (1 : 50) at 8000 g and a temperature of 37 to 40°C. The silver halide crystals were sensitized during centrifugation, and were then suspended in distilled water. The electron microscope grid or biological sample was covered by this suspension. An electron microphotograph showed an average crystal diameter of ~250 Å. The emulsions are being used in biological work. (TTT)

41210 CHARGE COLLECTION IN SILICON DETECTORS OPERATED WITH FIELD REGION LESS THAN RANGE OF ALPHA OR BETA PARTICLES. Keywell, Frank (Indiana State Univ., Terre Haute). J. Appl. Phys., 38: 3461-70(Aug. 1967).

The collection of charge in a silicon detector was studied for ionizing radiation of alpha and beta particles. In particular, the characteristics were studied for the case wherein the space-charge width of the detector is less than range of the ionizing particle. In this case there may be charge collection due to diffusion of electrons or holes to the edge of the space-charge region. The factors related to this type of collection are combined in a function termed the back-collection factor which is defined in an integral equation relating number of electron-hole pairs collected as a function of space-charge width. The back-collection factor is considered a function of distance from edge of space-charge region and amplifier-integration time. A method to calculate the back-collection factor as a series expansion is presented. Experimental data for 8.78- and 5.48-MeV alpha particles were analyzed to determine the range of back-collection and the form of its dependence on distance and integration time. The range of back-collection varies from 33 to 50 μ for integration time 0.1 to 5.0 μsec for 8.78-MeV alphas in silicon. Similarly, for 5.48-MeV alphas it varies from 16 to 52 μ. Beta particles required a different treatment because of their distribution of curved trajectories in a solid. The effect of this distribution in trajectories was considered in relation to the response of a silicon detector when space-charge width is less than range. It was noted that the previous experimental work by Agu et al., on absorption of electrons in aluminum foils of varying thickness should be in agreement with the count rate at full energy for a silicon detector when the albedo is included in the calculations. Experimental measurements were made on the number of electrons at full energy as a function of space-charge width for 264-keV conversion electrons from ^{203}Hg and these were shown to be in agreement with Agu's data. The results support the view that solid-state detectors may be used to measure ionization effects within the solid from which they are constructed. (auth)

41211 NEW PERFORMANCE CRITERION FOR LIQUID SCINTILLATION SPECTROMETRY. Roberts, W. A. (Beckman Instruments Ltd., Glenrothes, Scotland). Bio-Med. Eng., 2: 220-1(May 1967).

The widely used E^2/B so-called figure of merit is a convenient criterium of performance in a liquid scintillation counter calibrated for the measurement of a single-labeled sample, but it does not convey any information regarding the analytical performance of a dual-channel liquid scintillation spectrometer. A new figure of merit applicable to such instruments was recently derived and described. This Klein–Eisler number, P, is a composite of S which is the separation factor for the 2 isotopes, derived from: $S = [(R_2 + 0.1\ R_2R_1)\ (1 + 10\ R_2)/(R_2 + 10\ R_2R_1)\ (1 + 0.1\ R_2)]$, where R_1 and R_2 are the channel ratios for each isotope, and the efficiency for those isotopes in the discriminator windows that give S. The performance number is therefore: $P = [(S)\ (\text{eff}\ ^3H)\ (\text{eff}\ ^{14}C)/1000]$, where tritium and ^{14}C are the isotopes of interest. In other words, a tritium channel having 10% counting efficiency for ^{14}C has a smaller S than a tritium channel with only 5% efficiency for ^{14}C. The price paid for a high S is efficiency; the price paid for efficiency is counting time. Figures were compiled using an IBM 360 computer to calculate the data from Beckman liquid scintillation spectrometers. Maximum Klein–Eisler numbers ranged from 160 to 175. This represents a significant improvement upon figures originally plotted, which were based on the performance of an earlier model of the Beckman liquid scintillation spectrometer which had less efficient photomultiplier tubes. (BBB)

41212 DEPENDENCE OF DEAD TIMES OF GEIGER–MUELLER TUBES UPON BROMINE CONCENTRATION. Demjen, Z. G. (Polytechnic Univ., Budapest). Period. Polytech., Chem. Eng., 10: 217-28(1966).

Examination of bromine-quenched G–M tubes with an oscilloscope revealed a relation between the concentration of bromine and the dead times of the tubes. Measurements showed that with increasing bromine concentration the dead time of the tube decreases. A theoretical interpretation of this phenomenon is given. The increase of dead times with the decrease of bromine vapor tension originated from field charge increasing at a rapid pace. Though field charge greatly influences the motion of ions from the anode filament towards the cathode, on the other hand, with higher field charges also the absolute ion concentration is higher. Accordingly, as positive charges are present in the field, the screening effect increases. The increased screening effect lowers the field produced by the voltage fed to the filament to an extent corresponding to the magnitude of the charge. The experiments showed that this phenomenon is the origin of the increase of dead time with decreasing bromine concentration. The increase of the field charge has another consequence. With a higher field charge the critical radius at which the counter can count new signals also increases, although the mobility of the ions decreases also in the space extending to the critical radius, as it is the effective field that decreases. This is another reason why the dead time increases. It is proposed that halogen-quenched tubes should be used at voltages of 40 to 50 V above the starting voltage and the bromine tension in the tubes should be from 1 to 3 mm Hg to keep the dead time at a low level. (BBB)

41213 CONTRIBUTION TO THE MEASUREMENT OF THE EXPOSURE PRODUCED BY THE PHOTONS EMITTED BY ^{60}Co. Allisy, A. (Bureau International des Poids et Mesures, Sevres, France). Metrologia, 3: 41-51(Apr. 1967). (In French).

The transfer and dissipation of high-energy electromagnetic radiation in air is examined in the course of a mathematical analysis of the principles involved in exposure measurements for a photon beam produced by ^{60}Co, with free-air ionization chambers and cavity ionization chambers. A theoretical investigation was made involving certain simplifying assumptions, which are discussed. Special consideration is given to practical situations occurring in standardizing laboratories. Desirable shapes and dimensions for cavity ionization chambers are discussed. (BBB)

41214 A LARGE 4π PLASTIC SCINTILLATOR–DETECTOR WITH CLINICAL APPLICATIONS. Smith, A. H.; Clarke, S.; Reed, G. W. (Leeds Univ. General Infirmary, Leeds). Int. J. Appl. Radiat. Isotop., 18: 647-52(Sept. 1967).

An apparatus is described in which two 15-in.-dia plastic phosphors each with a central well cavity in one face, are so mounted that a sample of approximately 5 in. height by 5 in. diameter may be placed in the cylindrical space contained by the two wells. The lower phosphor is fixed; the upper may be raised and lowered by a motorized arm on a vertical column. The apparatus is housed within a lead-lined steel cubicle. The performance of the instru-

ment was evaluated in terms of resolution and peak-to-trough ratio for a wide range of γ-ray energies, and examples of its application in clinical problems are described. Its high sensitivity has permitted reduction in tracer doses, and this makes possible repeated investigations in, for example, ^{47}Ca absorption studies. (auth)

41215 SUPPRESSION OF INTERFERENCE PULSES IN RADIATION EXPERIMENTS. Hardy, J. A.; McCarroll, J. J. (Glasgow Univ.). J. Sci. Instrum., 44: 792-3(Sept. 1967).

Solid state detector systems can be seriously affected by the pick up of unwanted interference pulses. The susceptibility of such a system was investigated. The well known principle of anticoincidence was exploited to eliminate the effect of mains borne and reradiated interference. (auth)

41216 A γ SPECTROMETER FOR X-RAY STUDIES WITH SEMICONDUCTOR DETECTORS AND COOLED INPUT STAGE. Kalbitzer, S.; Melzer, W.; Stumpfl, W.; Walther, P. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Z. Angew. Phys., 23: 253-6(1967). (In German).

By cooling the input stage of a charge sensitive preamplifier the electronic noise was reduced to 360 eV (fwhm) Ge equivalent, obtained with a field effect transistor at 150°K, RC-RC pulse shaping of 3.2 μsec and at 0.0 pF external capacitance. With a Ge(Li)-detector the 75-keV x rays of ^{207}Pb were resolved with 950 eV (fwhm), the pulser width being about 850 eV. With a Si(Li)-detector the 6.4-keV x rays of ^{57}Fe were completely separated from the noise pulses. The resolution was 860 eV (fwhm), the pulser width 820 eV. (auth)

41217 CONTRIBUTION TO THE ACCURACY EVALUATION OF RADIOISOTOPE MEASUREMENT DEVICES. Lokajicek, Milos (Research Inst. of Nuclear Instruments, Prague). Jad. Energ., 13: 340-2(Sept. 1967). (In Czech).

In existing investigations of accuracy of measurements with radioisotope measuring devices, attention is paid practically only to the error caused by statistical fluctuations. A method is described which enables the fraction of the error caused by the instability (by nonreproducibility) of the measuring equipment to be determined from measured values. (auth)

41218 MEASUREMENT OF ANGULAR AND ENERGY DISTRIBUTION OF NEUTRONS RECOILED FROM DIFFERENT MEDIA. Goryachev, I. V.; Kukhtevich, V. I.; Trykov, L. A. (Inst. of Physics and Power Engineering, Obninsk, USSR). Jad. Energ., 13: 281-4(Aug. 1967). (In Czech).

A single-crystal scintillation spectrometer and a modified long counter were used for measuring angular distribution of neutrons reflected from iron, ground, and water with wide monochromatic reactor neutron beams with angles of incidence equal to 0, 30, 50, and 70°. (tr-auth)

41219 SYNTHESIS OF NUCLEAR EMULSIONS. Kubal, Josef (Inst. of Nuclear Research, Prague). Jad. Energ., 13: 291-6 (Aug. 1967). (In Czech).

Properties and the principles of laboratory preparation and treatment of nuclear emulsions are discussed. A review of original investigations and results of a Nuclear Emulsion Group in Radiologic Dosimetry Dept. of the Institute is presented. (auth)

41220 USE OF DOUBLE PULSE IONIZATION CHAMBERS FOR INVESTIGATING NUCLEAR REACTIONS. Dragnev, T.; Palazov, G. (Inst. of Physics, Academy of Sciences, Bulgaria). Compt. Rend. Acad. Bulg. Sci., 20: 277-80(1967). (In Russian).

The low counting efficiency of telescopes of semiconducting counters makes it difficult to collect information on energy and angular correlations of nuclear reactions. Double pulse chambers having grids with a maximum counting efficiency of ~4π give a high energy and angular resolution, and can be used with large targets. The electrical pulses occurring within a period of a few microseconds on the chamber electrodes are analyzed during the flight of two charged particles from the central chamber electrode into the two halves of the chamber. Two pulses from collecting electrodes in each half of the chamber and the positive pulse from the first grid of the second chamber are recorded on paper tape, and fed to a computer in order to obtain the energies and angles of both particles, and also the energy and angular distributions. At a neutron energy <0.6 MeV the identification is made on the basis of the amplitude ratio, and at a neutron energy >0.6 MeV the identification is made on the basis of the value of the positive pulse. This method has another significant advantage. An absorber having a definite thickness placed on the side of the second half of the chamber can be used to decrease the particle range. Then the collectrode will show a pulse proportional to the energy corresponding to the residual range, while a pulse depending on the angle of emission will appear on the grid. These three pulses will be sufficient to obtain the total energy and emission angles of both particles. (TTT)

41221 NEUTRON-GAMMA PULSE-SHAPE-DISCRIMINATION FOR BORON LOADED LIQUID SCINTILLATION DETECTORS. Suetterlin, L. Atomkernenergie, 12: 287-8(1967). (In German).

A pulse-shape-discrimination circuit is described for use on boron loaded liquid scintillation counters. The circuit described is a combination of the circuits developed by Brooks and Owen. Measurements show that the rate of discrimination is 1:2000. (auth)

41222 GAMMA DEFECTOSCOPE BETON FOR RADIOGRAPHIC STUDIES OF BUILDING CONSTRUCTIONS. Sul'kin, A. G.; Guslits, V. M.; Maiorov, A. N. Defektoskopiya, No. 3, 76-81(1967). (In Russian).

A new specialized gamma detector for the radiography of building constructions was described. The principal fabrication and operation parameters of the defectoscope are reported and some of its radiographic possibilities are indicated. (tr-auth)

41223 DETERMINATION OF THE SENSITIVITY OF SOME NEUTRON DETECTORS USED IN RADIOGRAPHY. Bukarev, V. A.; Gurvich, A. M.; Shtan, A. S.; Yaskevich, V. S. Defektoskopiya, No. 3, 71-6(1967). (In Russian).

The sensitivity of x-ray films in comparison with scintillators of ZnS(Ag) + B for slow neutron detection was investigated. The principles of the fabrication of the scintillator are described. A scheme for the construction of the moderator-shield installation was reported. It was found that the scintillators, containing enriched boron, make it possible to reduce the time of exposure in comparison with scintillators made with use of natural mixtures of boron isotopes. (tr-auth)

41224 MEASUREMENT OF THE COUNTING EFFICIENCY OF AN ASSOCIATED PARTICLE TIME-OF-FLIGHT SPECTROMETER. Kitazawa, Hideo; Kanda, Yukinori (Tokyo Inst. of Tech.). Tokyo Kogyo Daigaku Gakuho, No. 77, 11-18(Mar. 1967).

An associated particle time-of-flight spectrometer was constructed for the measurement of fast neutron scattering. The relative efficiencies of the spectrometer for neutrons of different energies were determined by measuring the yields of neutrons scattered by proton at known angles. The energy bias of a neutron counter was set at about 5 MeV. The absolute counting efficiency for 15 MeV neutrons was measured and was found to be in good agreement with the calculated value. (auth) (NSA of Japan)

41225 MEASUREMENT OF FISSION ANGULAR DISTRIBUTION IN SOLID STATE DETECTORS. Goennenwein, F.; Heinrich, H.; Hipp, H. (Univ., Tuebingen, Ger.). Z. Naturforsch., 22a: 1133-4(July 1967).

A method is described for taking angular distributions of fission fragments in solid detectors by an optical microscope. Results of two experiments, one using the reaction $^{238}U(\gamma,f)$ with a bremsstrahlung spectrum of 1604 MeV maximum energy and one using the reaction $^{238}U(n,f)$ with neutron energy of 4.65 MeV, are presented. (B.G.D.)

41226 APPROXIMATE FORMULAS FOR PHOTOELECTRIC COUNTING DISTRIBUTIONS. Bedard, Gabriel; Chang, Jane C.; Mandel, L. (Univ. of Rochester, N. Y.). Phys. Rev., 160: 1496-1500(Aug. 25, 1967).

The validity of a simple approximate formula for the photoelectric counting probability in a thermal optical field, is investigated. The formula is based on a generalization of the Bose-Einstein distribution and should hold for light of arbitrary spectral density. It is shown by explicit calculation for three different spectral distributions that the formula holds with good accuracy over a very wide range of conditions. It should therefore prove useful when the spectral distribution of the light being studied is not known. (auth)

41227 SPARK CHAMBERS: A SIMPLIFIED SYSTEM FOR THE OBSERVATION OF PARTICLE TRAJECTORIES IN TWO TYPES OF CHAMBERS. Sachs, A. M. (Columbia Univ., New York). Amer. J. Phys., 35: 582-94(July 1967).

A complete, simplified system was designed and constructed for two types of spark chamber demonstrations: a multiplate chamber for observation of penetrating cosmic rays; and a curtain-discharge chamber for observation of β rays from a radioactive source, with curved trajectories in a magnetic field. Attention was given to minimizing the cost of the components and the difficulties of fabrication and assembly. (auth)

41228 SPECIAL SCINTILLATING MATERIALS. Rudolph, F.; Sumi, K. (VEB Carl Zeiss, Jena, Ger.). Kernenergie, 10: 195-8(June 1967). (In German).

As a supplement to the paper concerning organic scintillators published in an earlier issue of this journal, some special designs not mentioned there are dealt with. The composition and the properties of both a light-tight plastic scintillator sensitive to beta particles and neutron-sensitive scintillators are discussed. Moreover, the possibility of systematic increasing gamma-ray sensitivity of plastic scintillators being also sensitive to beta radiation is shown. The studies have been closed already in 1962. (auth)

41229 EXTENSION OF THE RANGE OF DETERMINATION OF MANGANESE SULPHATE CONTENT FOR NEUTRON SOURCE MEASUREMENTS. De Volpi, A.; Armani, R. J.; Porges, K. G. (Argonne National Lab., Ill.). J. Nucl. Energy, 21: 521(June 1967).

Based on additional experimental data up to 515 g/l equations are presented which give the concentration of manganese sulfate at 30°C for neutron source measurements as a function of solution density. (B.G.D.)

41230 THEORY FOR THE DEVELOPMENT OF TRACK HOLES IN SOLID STATE NUCLEAR TRACK DETECTORS. Somogyi, Gyorgy. ATOMKI (At. Kut. Intez.) Kozlem., 9: 77-89(June 1967). (In Hungarian).

A general theory is described for the development of track holes in solid state nuclear track detectors. Based on this theory the existence of a correlation between the diameters of track holes and the energy of particles was proven. A sandwich technique was applied for direct demonstration of the effect in case of fission fragments entering into glass. The theory is extended to the particles entering at any angles into the detector, and the validity of the theoretical function for diameter of the track hole versus the intering angle of particles is proved experimentally. (auth)

41231 DETERMINATION OF GEOMETRY FACTOR. Komarek, P. (Technische Hochschule, Vienna). Atomkernenergie, 12: 331-3(1967). (In German).

The methods well known from literature for analytical ascertainment of geometry factors are compared and analyzed with regard to its limits. The polynom-formula investigated by Bachmann yields correct results, if D/h $\leq$ 1 (D radius of the source, h distance between source and detector). The integral-formula investigated by Henrich is shown to be analytically exact in all cases. It is pointed out that there is existing a critical range of distances in each experimental arrangement, in which small changes of distance cause strong fluctuations of the geometry factor. A method for experimental determination of the geometry of large plain sources was developed, whose results agree quite well with calculated values. (auth)

41232 PROPORTIONAL COUNTER SPECTROMETER FOR THE STUDY OF THE SOLAR SOFT X-RAY SPECTRUM. Culhane, J. L. (London Univ.); Sanford, P. W.; Willmore, A. P.; Blades, J.; Nettleship, R. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: No. 4, 38-51(Aug. 1967).

An instrument, containing seven proportional counter detectors, has been designed for flight on the NASA Orbiting Solar Observatory-D. The wavelength band 1-18 Å is divided into 24 energy intervals by means of pulse-height analysis. Five detectors are employed in this wavelength range; two of them provide low sensitivity alternatives at the short wavelength end of the range. Low sensitivity detectors are selected automatically by the instrument in response to increased solar X-ray activity. Two additional detectors are employed for the 44-55 Å and 44-62 Å wavelength bands. A calibration system, employing radioactive sources, is used for in flight calibration of all the detectors and electronic systems. Detectors are connected sequentially to a single main amplifier and eight-channel pulse-height analyzer. A data compression system is employed to make economical use of the available telemetry words. High voltages for the detectors are derived from two inverter circuits which employ corona stabiliser tubes. Two redundant inverter circuits provide low voltage supplies for the instrument. A spectrum in the range 1-18 Å can be obtained every sixteen seconds. (auth)

41233 TRANSIENT RESPONSE OF SURFACE BARRIER DETECTORS AS A FUNCTION OF FISSION FRAGMENT ENERGY. Krulisch, A. H.; Axtmann, R. C. Contract AT(30-1)-2807. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: No. 4, 58-63(Aug. 1967). (NYO-2807-31).

The transient response of silicon surface barrier detectors to fission fragments of ^{252}Cf was observed over a range of incident fragment energies from 13.6 to 90 MeV. From these observations the effect of the plasma formed by the incident particle on the charge collection time was determined. The time to disperse the plasma, t_p, was calculated as a function of incident particle energy, E_0, and applied field, E. It was found that $t_p \propto E_0^{1/m}$ where $2 \leq m \leq 3$ and $t_p \propto E^{-1}$. A simple model gave reasonable agreement with the experiments and indicated that the plasma is dispersed by field-enhanced diffusion. (auth)

41234 SEMICONDUCTOR RADIATION DETECTORS OF CZECHOSLOVAK PROVENANCE. Gilar, Oldrich; Hanzlik, Jiri (Research Inst. of Nuclear Instruments, Prague). Jad. Energ., 13: 269-74(July 1967). (In Czech).

In 1965, the applied research and the development of the design and technology of semiconductor radiation detectors were finished in the Research Institute of Nuclear Instruments of the Tesla-Pardubice National Enterprise. The main types of these detectors were produced in the pilot plant of the Institute from 1966. A brief review is given of the main types of this kind of detectors, and at their properties and parameters. (auth)

41235 THE METHOD OF ASSOCIATED PARTICLES IN THE TIME-OF-FLIGHT NEUTRON SPECTROMETRY AND ITS APPLICATION TO T(d,n)^{4}He REACTION. Seeliger, D.; Wiesner, K. (Institut fuer Experimentelle Kernphysik, Dresden). Kernenergie, 10: 214-15(July 1967). (In German).

A fast neutron time-of-flight spectrometer based on the associated particles technique is described. The detectors are stilbene or plastic scintillators in connection with short-time photomultipliers of the K 14 FS 50 type. Both the time resolution of the spectrometer and the profile of the electronically collimated neutron beam are determined. (auth)

41236 SELECTION OF THE MEASURING CONDITIONS IN TWO-CHANNEL COUNTING. Winkler, K. (Institut fuer Physikalische Chemie, Berlin). Kernenergie, 10: 216-20(July 1967). (In German).

General relations between error and measuring time are derived for functions which depend on several quantities determined in measurements of nuclear radiation. Three possible methods of measurement are taken into consideration: the method of equal measuring time (preset time technique), the method of equal number of counts (preset count technique), and the method of minimum condition. After specification of the relationships with respect to the two-channel counting of two nuclides, examples are given and the efficiencies of the different methods are compared with each other. (auth)

41237 PROGRAMMING FOR FLYING SPOT DEVICES. Proceedings of the 1967 International Conference held at Munich, January 18-20, 1967. Powell, B. W.; Seyboth, P. (eds.). Munich, Max-Planck-Institut fuer Physik und Astrophysik, 1967. 433p. (CONF-670105).

Separate abstracts were prepared for thirty-three of thirty-eight papers presented. Five papers were previously included in NSA. For abstract numbers of these papers see CONF 670105 in a cumulative report number index. (W.H.K.)

For abstracts of individual papers see: 41238-41270.

41238 CYCLOPS: A FLYING SPOT DIGITIZER FOR SPARK CHAMBER FILM ANALYSES. MacEwan, J. F.; Sharp, P. H. (Rutherford High Energy Lab., Chilton, Eng.). pp 5-11 of Programming for Flying Spot Devices. Powell, B. W.; Seyboth, P. (eds.). Munich, Max-Planck-Institut fuer Physik und Astrophysik, 1967.

From International Conference on Flying Spot Devices, Munich, Jan. 18-20, 1967. See CONF-670105.

The design, operation, and performance of CYCLOPS, a flying spot digitizer for spark chamber film analysis, are discussed. The digitizer works on a principle similar to that of an HPD with both x and y coordinates being determined by glass gratings. (B.G.D.)

41239 SOFTWARE FOR THE FSD CYCLOPS IN OPERATION AT THE RUTHERFORD HIGH ENERGY LABORATORY. Redman, A. J.; Sparrow, J.; Wagon, D. J. (Rutherford High Energy Lab., Chilton, Eng.). pp 12-23 of Programming for Flying Spot Devices. Powell, B. W.; Seyboth, P. (eds.). Munich, Max-Planck-Institut fuer Physik und Astrophysik, 1967.

From International Conference on Flying Spot Devices, Munich, Jan. 18-20, 1967. See CONF-670105.

The use of a DDP-224 computer for control of CYCLOPS, a flying spot digitizer, and for real time calculations of particle track parameters in spark chambers is discussed. Topics include spark reconstruction, electron shower finding, and future developments. (B.G.D.)

41240 AUTOMATIC PROCESSING OF SPARK CHAMBER PICTURES AT DESY. Becker, U. (Deutsches Elektronen-Synchrotron, Hamburg); Dahlmann, K.; Hoehne, K.; Weber, J.; Smith, J. H. pp 24-32 of Programming for Flying Spot Devices. Powell, B. W.; Seyboth, P. (eds.). Munich, Max-Planck-Institut fuer Physik und Astrophysik, 1967.

From International Conference on Flying Spot Devices, Munich, Jan. 18–20, 1967. See CONF-670105.

The automatic processing of spark chamber film at DESY using a flying spot digitizer for digitizing the data and storing it on magnetic tape for later analysis is discussed. (B.G.D.)

41241 THE MEASUREMENT OF SPARK CHAMBER FILM AT CERN USING THE HPD I. Bowen, R. A.; Davies, H. E.; Lassalle, J. C.; Wilson, J.; Zanella, P. (CERN, Geneva). pp 75-85 of Programming for Flying Spot Devices. Powell, B. W.; Seyboth, P. (eds.). Munich, Max-Planck-Institut fuer Physik und Astrophysik, 1967.

From International Conference on Flying Spot Devices, Munich, Jan. 18–20, 1967. See CONF-670105.

The current measurement of spark chamber films with the CERN HPD I and the experience obtained operating on-line to the CDC 6600 are discussed. The work being done on the standardization of programs to reduce the programming time for a new experiment to a minimum is also discussed. (B.G.D.)

41242 THE MEASUREMENT OF SPARK CHAMBER FILM AT CERN USING LUCIOLE. Andersson, T. F.; Blackall, P. M.; Daug, J.; Head, A. E.; Metcalf, M. B.; Weights, V. J. (CERN, Geneva). pp 86-97 of Programming for Flying Spot Devices. Powell, B. W.; Seyboth, P. (eds.). Munich, Max-Planck-Institut fuer Physik und Astrophysik, 1967.

From International Conference on Flying Spot Devices, Munich, Jan. 18–20, 1967. See CONF-670105.

The operating and programming methods used to automatically scan and measure spark chamber pictures using the cathode-ray-tube digitizer LUCIOLE are described. (auth)

41243 SIMPLE COMPUTER-CONTROLLED FLYING SPOT DIGITIZER FOR SPARK CHAMBER PHOTOGRAPHS. Scharff-Hansen, P.; Willits, T. R. (CERN, Geneva). pp 98-106 of Programming for Flying Spot Devices. Powell, B. W.; Seyboth, P. (eds.). Munich, Max-Planck-Institut fuer Physik und Astrophysik, 1967.

From International Conference on Flying Spot Devices, Munich, Jan. 18–20, 1967. See CONF-670105.

A device is described which uses a small computer to control a commercial oscilloscope. It was originally designed as a simple solution to the measurement of pictures from a particular experiment. However, the principle of operation is adaptable to any kind of spark chamber pictures. (auth)

41244 UTILIZATION OF AN ON-LINE MEASURING SYSTEM. Ouannes, C.; Garic, B.; Garic, F.; Makowski, B.; Sauvage, M. (Institut de Physique Nucleaire, Orsay, France). pp 107-12 of Programming for Flying Spot Devices. Powell, B. W.; Seyboth, P. (eds.). Munich, Max-Planck-Institut fuer Physik und Astrophysik, 1967.

From International Conference on Flying Spot Devices, Munich, Jan. 18–20, 1967. See CONF-670105.

A bubble chamber measuring system is described which has the following two features: it is one of the users of a computing center also devoted to other duties and the geometrical reconstruction is performed in real time, immediately after the measurement. This system is composed of 6 IEP and 5 SMP measuring machines connected to a CDC 3200 computer coupled to a CDC 3600 computer. (auth)

41245 THE PURDUE SMP SYSTEM. Christian, Richard S.; Loeffler, Frank J.; Kovacs, Arthur Z.; McIlwain, Robert L. Jr.; Tautfest, George W.; Wagner, Roger E. (Purdue Univ., Lafayette, Ind.). pp 113-19 of Programming for Flying Spot Devices. Powell, B. W.; Seyboth, P. (eds.). Munich, Max-Planck-Institut fuer Physik und Astrophysik, 1967.

From International Conference on Flying Spot Devices, Munich, Jan. 18–20, 1967. See CONF-670105.

The time-sharing aspects of the Purdue SMP system as developed over the last two years and projected about one year in the future are discussed. (B.G.D.)

41246 EXPERIENCE WITH THE GLASGOW SMP SYSTEM. Browning, G. K. S.; Robertson, G. H.; Robinson, C. J. (Univ. of Glasgow). pp 120-9 of Programming for Flying Spot Devices. Powell, B. W.; Seyboth, P. (eds.). Munich, Max-Planck-Institut fuer Physik und Astrophysik, 1967.

From International Conference on Flying Spot Devices, Munich, Jan. 18–20, 1967. See CONF-670105.

The operation and performance of the three SMP bubble chamber film measuring machines at Glasgow controlled by an IBM 7044 computer are discussed. Topics include comparison with SMP's at Berkeley, programming innovations, and performance statistics. (B.G.D.)

41247 STATUS REPORT ON SMP: HEIDELBERG. Mokry, P. (Institut fuer Hochenergiephysik, Heidelberg). pp 130-8 of Programming for Flying Spot Devices. Powell, B. W.; Seyboth, P. (eds.). Munich, Max-Planck-Institut fuer Physik und Astrophysik, 1967.

From International Conference on Flying Spot Devices, Munich, Jan. 18–20, 1967. See CONF-670105.

The operation of the four Heidelberg SMP bubble chamber film scanning and measuring machines on-line with an IBM-7040 is discussed. Topics include the CROSS subroutine, the POINT subroutine, accuracy of measurement of fiducials in normal production measurement, and accuracy of measurement of tracks. (B.G.D.)

41248 PROPOSAL FOR A REAL-TIME PROCESSING OF POST KINEMATICS DATA. Ouannes, C.; Garic, B.; Makowski, B. (Institut de Physique Nucleaire, Orsay, France). pp 139-46 of Programming for Flying Spot Devices. Powell, B. W.; Seyboth, P. (eds.). Munich, Max-Planck-Institut fuer Physik und Astrophysik, 1967.

From International Conference on Flying Spot Devices, Munich, Jan. 18–20, 1967. See CONF-670105.

A system is proposed which would provide an access to a bubble chamber data library and allow an easy method for obtaining histograms immediately. The system was designed for CDC computers, but it is possible to use on any equipment meeting similar specifications. (B.G.D.)

41249 USE OF COMPUTERS IN FSD SYSTEMS. Lord, D. H. (CERN, Geneva). pp 147-58 of Programming for Flying Spot Devices. Powell, B. W.; Seyboth, P. (eds.). Munich, Max-Planck-Institut fuer Physik und Astrophysik, 1967.

From International Conference on Flying Spot Devices, Munich, Jan. 18–20, 1967. See CONF-670105.

The future use of computers in entire FSD bubble or spark chamber data processing systems is discussed. Topics include hardware, data processing (FSD operation, gate, and filter), data processing (geometry, kinematics, and statistics) and overall management of the FSD system. (B.G.D.)

41250 PROBLEMS AND PROGRESS IN THE INTEGRATION OF AN FSD MEASUREMENT FACILITY AND A BUBBLE CHAMBER PHYSICS RESEARCH PROGRAM. Crennell, D. J.; Culwick, B. B.; Hough, P. V. C.; Nardi, J. A.; Skillicorn, I. O.; Strand, R. C. (Brookhaven National Lab., Upton, N. Y.). pp 159-70 of Programming for Flying Spot Devices. Powell, B. W.; Seyboth, P. (eds.). Munich, Max-Planck-Institut fuer Physik und Astrophysik, 1967.

From International Conference on Flying Spot Devices, Munich, Jan. 18–20, 1967. See CONF-670105.

A general description of the Brookhaven FSD measurement facility in conjunction with bubble chamber research is presented. The Brookhaven FSD development and improvement program is discussed. (W.H.K.)

41251 SOME SPECIAL FEATURES OF THE BROOKHAVEN REAL-TIME FSD PROGRAM. Abrams, K.; Goldberg, A.; Hough, P. V. C.; Jessup, S.; Nardi, J. A.; Strand, R. C. (Brookhaven National Lab., Upton, N. Y.). pp 171-84 of Programming for Flying Spot Devices. Powell, B. W.; Seyboth, P. (eds.). Munich, Max-Planck-Institut fuer Physik und Astrophysik, 1967.

From International Conference on Flying Spot Devices, Munich, Jan. 18–20, 1967. See CONF-670105.

A rewrite of the Brookhaven FSD program system which controls the FSD, finds fiducials, and gates the contents of 400-micron-wide roads onto magnetic tape for subsequent filtering is discussed. The special features of this system are briefly pointed out. (W.H.K.)

41252 EXPERIENCE WITH THE CERN HPD ROAD GUIDANCE SYSTEM. Blair, W.; Foster, M.; Gavillet, Ph.; (and others) (CERN, Geneva). pp 185-99 of Programming for Flying Spot Devices. Powell, B. W.; Seyboth, P. (eds.). Munich, Max-Planck-Institut fuer Physik und Astrophysik, 1967.

From International Conference on Flying Spot Devices, Munich, Jan. 18–20, 1967. See CONF-670105.

The CERN road guidance system with the HPD-1 on-line to a CDC 6600 computer is outlined. An efficiency study concluded that too large a fraction of the time loss is caused by the computer operating system and hardware. The results obtained are found to be as good as the IEP results. (W.H.K.)

41253 PROGRAMMING SYSTEM OF THE COLLEGE DE FRANCE OFF-LINE HPD. Equer, B.; Ton That, B.; Volte, A. (College de France, Paris). pp 200-10 of Programming for Flying Spot Devices. Powell, B. W.; Seyboth, P. (eds.). Munich, Max-Planck-Institut fuer Physik und Astrophysik, 1967.

From International Conference on Flying Spot Devices, Munich, Jan. 18–20, 1967. See CONF-670105.

The Paris off-line HPD system and a new program system are described. A test experiment for the HPD system is described and discussed. (W.H.K.)

41254 A NEW HPD FILTERING TECHNIQUE FOR BUBBLE CHAMBER PICTURES. Adler, J.; Bloch, M.; Equer, B.; Volte, A. (College de France, Paris). pp 211-39 of Programming for Flying Spot Devices. Powell, B. W.; Seyboth, P. (eds.). Munich, Max-Planck-Institut fuer Physik und Astrophysik, 1967.

From International Conference on Flying Spot Devices, Munich, Jan. 18–20, 1967. See CONF-670105.

The methods and programs of a new HPD filtering technique are described. The principal features are an initial noise–track separation and an optimization technique which tries to find track parameters which maximize some quality function, thus increasing the efficiency. (W.H.K.)

41255 COMPUTER CONTROLLED ELECTRONIC GATE FOR THE REDUCTION OF HPD DIGITIZINGS. Guignard, Claude (College de France, Paris). pp 240-6 of Programming for Flying Spot Devices. Powell, B. W.; Seyboth, P. (eds.). Munich, Max-Planck-Institut fuer Physik und Astrophysik, 1967.

From International Conference on Flying Spot Devices, Munich, Jan. 18–20, 1967. See CONF-670105.

The advantages and general principles of a computer controlled electronic gate for reducing the number of digitizings in an off-line HPD system are presented. Pregating times of a computer are compared to those of computer controlled electronic gates. (W.H.K.)

41256 HPD PERFORMANCE UNDER CONTROL OF A SMALL COMPUTER. Leblond, Ph. (College de France, Paris). pp 247-53 of Programming for Flying Spot Devices. Powell, B. W.; Seyboth, P. (eds.). Munich, Max-Planck-Institut fuer Physik und Astrophysik, 1967.

From International Conference on Flying Spot Devices, Munich, Jan. 18–20, 1967. See CONF-670105.

A small computer was used to control the film advance, stage positioning, and the measuring conditions of the HPD. Its performance under these conditions is studied. Modifications included simplifying formats due to limited memory space and transferring the masking operation to the electronic equipment to save time. (W.H.K.)

41257 STATUS OF HPD PROGRAMS AT SACLAY. De Brion, J. P.; Frank, C.; Grandidier, M.; Leveque, A.; Riols, G.; Sabattie, L. (CEN, Saclay, France). pp 254-8 of Programming for Flying Spot Devices. Powell, B. W.; Seyboth, P. (eds.). Munich, Max-Planck-Institut fuer Physik und Astrophysik, 1967.

From International Conference on Flying Spot Devices, Munich, Jan. 18–20, 1967. See CONF-670105.

A preliminary report on the off-line HPD system at Saclay is presented. The principal features of the system are reviewed, and preliminary test results are discussed. (W.H.K.)

41258 PRELIMINARY RESULTS OF THRESH AND GRIND OBTAINED FROM FSD–IBM 7094 MEASURED EVENTS. Di Lazzaro, M. A.; Luvisetto, M. L.; Masetti, M.; Misuri, G. (Istituto Nazionale di Fisica Nucleare, Bologna). pp 259-64 of Programming for Flying Spot Devices. Powell, B. W.; Seyboth, P. (eds.). Munich, Max-Planck-Institut fuer Physik und Astrophysik, 1967.

From International Conference on Flying Spot Devices, Munich, Jan. 18–20, 1967. See CONF-670105.

Preliminary results of the kinematical analysis of the first events measured with the FSD–IBM 7094 are presented. Rejection rate, measurement reproducibility, and measurement precision are discussed. (W.H.K.)

41259 THE SYSTEM FSD–IBM 7094 BUILT AT CNAF. Carita, E.; Luvisetto, M. L.; Masetti, M.; Sini, G. P.; Venturi, D.; Zanotti, U. (Istituto Nazionale di Fisica Nucleare, Bologna). pp 265-70 of Programming for Flying Spot Devices. Powell, B. W.; Seyboth, P. (eds.). Munich, Max-Planck-Institut fuer Physik und Astrophysik, 1967.

From International Conference on Flying Spot Devices, Munich, Jan. 18–20, 1967. See CONF-670105.

The FSD–IBM 7094 system is briefly described and compared to other systems. Future developments for this system are summarized. (W.H.K.)

41260 CALIBRATION AND TEST PROGRAMS FOR THE FSD SYSTEM. Luvisetto, M. L.; Masetti, M.; Mignoli, A. (Istituto Nazionale di Fisica Nucleare, Bologna). pp 271-84 of Programming for Flying Spot Devices. Powell, B. W.; Seyboth, P. (eds.). Munich, Max-Planck-Institut fuer Physik und Astrophysik, 1967.

From International Conference on Flying Spot Devices, Munich, Jan. 18–20, 1967. See CONF-670105.

A chain of programs that compute various constants that determine the precision of the HPD measurements is presented. Check programs are included which detect any malfunction of the HPD. (W.H.K.)

41261 FUTURE DEVELOPMENTS OF CNAF FSD SYSTEM. Luvisetto, M. L.; Masetti, M. (Istituto Nazionale di Fisica Nucleare, Bologna). pp 285-94 of Programming for Flying Spot Devices. Powell, B. W.; Seyboth, P. (eds.). Munich, Max-Planck-Institut fuer Physik und Astrophysik, 1967.

From International Conference on Flying Spot Devices, Munich, Jan. 18–20, 1967. See CONF-670105.

Plans to use a medium-sized computer to filter the data from flying spot devices before the data goes to the IBM 7094 computer are presented. The FSD is on-line to the medium-sized computer which is on-line to the IBM 7094. Advantages are improved efficiency and smaller production expenses. (W.H.K.)

41262 CURRENT STATUS OF THE MUNICH HPD SYSTEM. Freund, P.; Laatsch, J.; Schnecke, J.; Seyboth, P.; Seyerlein, J.; Weigl, J. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). pp 295-300 of Programming for Flying Spot Devices. Powell, B. W.; Seyboth, P. (eds.). Munich, Max-Planck-Institut fuer Physik und Astrophysik, 1967.

From International Conference on Flying Spot Devices, Munich, Jan. 18–20, 1967. See CONF-670105.

A brief description of the Munich HPD system is presented. The system's main computer is the IBM 7090, and two PDP-8 computers have been integrated into the HPD system. It is not yet operational. (W.H.K.)

41263 THE SPIRAL READER: 1966. Burkhard, J. (Univ. of California, Berkeley). pp 301-13 of Programming for Flying Spot Devices. Powell, B. W.; Seyboth, P. (eds.). Munich, Max-Planck-Institut fuer Physik und Astrophysik, 1967.

From International Conference on Flying Spot Devices, Munich, Jan. 18–20, 1967. See CONF-670105.

A current report on the Spiral Reader system is presented. Improvements in efficiency, quality control, and economy of production are discussed. (W.H.K.)

41264 THE STATUS OF THE PEPR POINT GUIDANCE SYSTEM. Yamamoto, Richard K. (Massachusetts Inst. of Tech., Cambridge). pp 314-28 of Programming for Flying Spot Devices. Powell, B. W.; Seyboth, P. (eds.). Munich, Max-Planck-Institut fuer Physik und Astrophysik, 1967.

From International Conference on Flying Spot Devices, Munich, Jan. 18–20, 1967. See CONF-670105.

Some major programming modifications for the PEPR Point Guidance System and the present status of the system are discussed. Partial results of production operation are presented. (W.H.K.)

41265 THE POLLY SYSTEM FOR BUBBLE CHAMBER FILM MEASURING. Hodges, Donald (Argonne National Lab., Ill.). pp 329-35 of Programming for Flying Spot Devices. Powell, B. W.; Seyboth, P. (eds.). Munich, Max-Planck-Institut fuer Physik und Astrophysik, 1967.

From International Conference on Flying Spot Devices, Munich, Jan. 18–20, 1967. See CONF-670105.

The design and work on the POLLY bubble chamber film measuring system at Argonne National Laboratory are presented. The prototype system and the final production system which are being built are described. (W.H.K.)

41266 USE OF INTERACTIVE GRAPHICAL CONSOLES IN BUBBLE CHAMBER FILM ANALYSIS. Clark, Robert K. (Argonne National Lab., Ill.). pp 336-45 of Programming for Flying Spot Devices. Powell, B. W.; Seyboth, P. (eds.). Munich, Max-Planck-Institut fuer Physik und Astrophysik, 1967.

From International Conference on Flying Spot Devices, Munich, Jan. 18–20, 1967. See CONF-670105.

The planned operator console for the POLLY bubble chamber film analyzing system at the Argonne National Laboratory is described. Good communication between operator and computer is emphasized. (W.H.K.)

41267 PROGRESS WITH A MINIMUM GUIDANCE PROGRAM AT CERN AND RHEL. Ferran, M. (CERN, Geneva); Gerard, J.; Head, A.; Moorhead, G.; Sambles, A.; Searle, J.; Burren, J. pp 346-61 of Programming for Flying Spot Devices. Powell, B. W.; Seyboth, P. (eds.). Munich, Max-Planck-Institut fuer Physik und Astrophysik, 1967.

From International Conference on Flying Spot Devices, Munich, Jan. 18–20, 1967. See CONF-670105.

The present state of a minimum guidance program for the HPD

systems at CERN and RHEL is outlined. The form of digitizings input, the data available for testing, and the program organization for these systems are discussed. (W.H.K.)

41268 BUBBLE CHAMBER DATA PROCESSING SYSTEM FOR THE ILLIAC III COMPUTER. McCormick, Bruce H.; Uchiyama-Campbell, Fumiyo (Univ. of Illinois, Urbana). pp 362-5 of Programming for Flying Spot Devices. Powell, B. W.; Seyboth, P. (eds.). Munich, Max-Planck-Institut fuer Physik und Astrophysik, 1967.

From International Conference on Flying Spot Devices, Munich, Jan. 18–20, 1967. See CONF-670105.

The scanning program of the ILLIAC III computer for analyzing bubble chamber data is outlined. This program selects for each local area of the film the most appropriate choice of the four film digitization formats and its associated track element recognition procedure. (W.H.K.)

41269 SIMULATION STUDIES WITH SATR. Thompson, Murray A. (Univ. of Wisconsin, Madison). pp 366-79 of Programming for Flying Spot Devices. Powell, B. W.; Seyboth, P. (eds.). Munich, Max-Planck-Institut fuer Physik und Astrophysik, 1967.

From International Conference on Flying Spot Devices, Munich, Jan. 18–20, 1967. See CONF-670105.

The design of SATR (Stereo Analogue Track Recognition) for bubble chamber film analysis is discussed. SATR automatically scans and measures. The system has been tested by replacing multiple analog operations by sequential digital operations and has produced satisfactory results. (W.H.K.)

41270 CURRENT STATUS OF AUTOMATIC SCANNING AT COLUMBIA UNIVERSITY. Burd, D.; Teitelbaum, R. (Columbia Univ., New York). pp 398-408 of Programming for Flying Spot Devices. Powell, B. W.; Seyboth, P. (eds.). Munich, Max-Planck-Institut fuer Physik und Astrophysik, 1967.

From International Conference on Flying Spot Devices, Munich, Jan. 18–20, 1967. See CONF-670105.

Progress at Columbia University in the development of an automatic scanning system for bubble chamber film is discussed. The Brookhaven track-following program and its associated executive routine are being used with modifications. Its basic approach is a real-time initialization and track-following of all tracks in a frame with no human pre-scanning. (W.H.K.)

41271 METHOD AND DEVICE FOR PULSE SHAPE DISCRIMINATION. Laguerre, Rene (to Commissariat a l'Energie Atomique). British Patent 1,083,441. Sept. 13, 1967. Priority date Jan. 12, 1965, France.

A pulse shape discriminator is described for use with a scintillation detector. The discriminator selects pulses from a train of pulses having the same polarity and different decay rates. (B.G.D.)

41272 SYSTEM FOR AC OPERATION OF AN IONIZATION CHAMBER. (to Japan Atomic Energy Research Institute). British Patent 1,082,960. Sept. 13, 1967. Priority date Dec. 23, 1963, Japan.

A scheme is described for ac operation of an ionization chamber which supplies the chamber with an alternating driving voltage, and amplifies selectively the harmonics of the resulting output current from the chamber suitably to indicate the intensity of radiation in the chamber. (B.G.D.)

41273 CIRCUIT ARRANGEMENT FOR FLATTENING AN ENERGY RESPONSE OF A SCINTILLATION COUNTER IN BIAS MODULATION OF A THRESHOLD DISCRIMINATOR. (to Japan Atomic Energy Research Institute). British Patent 1,082,957. Sept. 13, 1967. Priority date Nov. 1, 1963, Japan.

A circuit is described for bias modulation of a threshold discriminator for flattening the energy response characteristic of a scintillation detector which expresses the relative response (i.e., the ratio of the counts to radiation dose (exposure or absorbed dose)) as a function of the incident gamma ray energy. (B.G.D.)

41274 PHOSPHORS. (to The Harshaw Chemical Co.). British Patent 1,082,732. Sept. 13, 1967. Priority date Jan. 21, 1964, United States.

A scintillator for use in detection of ionizing radiation, which comprises calcium iodide activated by tin present in amounts from 10 to 400 ppM by weight, is described. (B.G.D.)

Radiation Dosimeters

Refer also to abstract 42813.

41275 (BNWL-SA-1003) MICRODOSIMETRY. Glass, W. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec. 19, 1966. Contract AT(45-1)-1830. 14p. (CONF-670324-1). Dep. CFSTI.

From Radiological Sciences Seminar, Seattle, Wash.

Microscopic dosimetry, which involves the statistical distribution of absorbed energies in an irradiated medium, is discussed. The medium used in the experiments simulate soft tissue for radiobiological application. Data are given for the dose distribution and the probability distribution for local energy density in simulated tissues exposed to gamma rays and monoenergetic neutrons. (W.H.K.)

41276 (COO-1105-134) PRE-IRRADIATION ANNEALING EFFECTS ON THE THERMOLUMINESCENCE AND OPTICAL ABSORPTION IN LiF:Mg AND LiF (TLD-100). Rhyner, C. R.; Cameron, J. R. (Wisconsin Univ., Madison. Dept. of Physics). July 15, 1967. Contract AT(11-1)-1105. 12p. Dep. CFSTI.

Characteristic effects of pre-irradiation annealing on the thermoluminescence and optical properties in magnesium-doped lithium fluoride and lithium fluoride (TDL-100) were studied. The pre-annealing characteristics as a function of exposure were mainly studied, and the experimental results are graphed. (W.H.K.)

41277 (COO-1105-135) A TLD READER FOR MBLE DOSIMETERS. DeWerd, L. A.; Cameron, J. R. (Wisconsin Univ., Madison. Dept. of Physics). July 15, 1967. Contract AT(11-1)-1105. 7p. Dep. CFSTI.

The design of a reader for a thermoluminescent dosimeter is presented. The dosimeter consists of the natural calcium chloride phosphor bonded on a nickel cylindrical tube which is indirectly heated by a tungsten filament and all contained in an evacuated glass tube. Diagrams of the reader circuit and the circuit for measuring maximum peak height during a heating cycle are included. (W.H.K.)

41278 (COO-1105-136) PRELIMINARY INVESTIGATION IN THE USE OF THERMOLUMINESCENCE FOR ULTRAVIOLET DOSIMETRY. Wilson, C. R.; Lin, F. M.; Cameron, J. R. (Wisconsin Univ., Madison. Dept. of Radiology). July 15, 1967. Contract AT(11-1)-1105. 13p. Dep. CFSTI.

A preliminary investigation of the use of thermoluminescent calcium fluoride for ultraviolet dosimetry is presented. The transferred thermoluminescent response as a function of untraviolet exposure and the sensitivity as a function of wavelength are discussed. (W.H.K.)

41279 (IDO-12060) EXPERIMENTAL OBSERVATIONS IN THERMOLUMINESCENT DOSIMETRY AT THE NATIONAL REACTOR TESTING STATION. Cusimano, John P. (Idaho Operations Office (AEC), Idaho Falls). Mar. 1967. 10p. Dep. CFSTI.

Lithium fluoride is an almost ideal dosimetric material for ionizing radiation. A commercial thermoluminescent dosimetry system was purchased and much experimental work has been done in order to determine the efficiency and reliability of a lithium fluoride system, as well as of various lithium fluoride dosimeters. Efforts were concentrated on evaluating a lithium fluoride-teflon dosimeter. This dosimeter is a 13 mm teflon disc 0.4 mm in thickness with 28 milligrams of lithium fluoride phosphor of some 200 tyler mesh uniformly distributed in the teflon matrix. It is unbreakable, leakproof and assures an even distribution of the lithium fluoride phosphor both during irradiation and during the critical readout cycle. The routine handling is quite simple and eliminates most of the problems of other dosimeters. An intensive program of testing was performed to determine accuracy, reproducibility, response to light, heat, humidity and handling, as well as to beta and gamma radiation. Satisfactory results concerning the above considerations are discussed as well as other tests, such as the application of lithium fluoride in reactor-destruct-test dosimetry using tissue-equivalent phantoms. (auth)

41280 RADIOPHOTOLUMINESCENT DOSIMETRY. Becker, K. (Nuclear Research Establishment, Juelich, Ger.). At. Energy Rev., 5: 43-95(Apr. 1967).

The development and present status of silver-activated radiophotoluminescent phosphate glasses, their dosimetric properties, and their application are reviewed on the basis of more than 300 articles, reports, lectures, patents, expertises, etc., which have been written since 1948. After a brief historical survey the theory of radiophotoluminescence (RPL) and the main general characteristics of dosimeter glasses, such as different aspects for the choice of optimal glass composition, are briefly discussed. Also surveyed are the basic dosimetric properties of RPL glasses of different composition—in particular the kinetic behavior (buildup and fading), dose range, accuracy, effect of dose-rate, LET, temperature and light, the particular problems of x- and gamma-ray

dosimetry (energy and directional dependence); the dosimetry of corpuscular radiation (thermal and fast neutrons, electrons and charged particles); the applications of glass dosimeters in personnel dosimetry (badge design, organization, etc.); special applications, for example, for radiobiological and medical dosimetry; and the design of readers. Finally, the relative advantages and disadvantages of glass dosimeters are compared with other systems (film, TLD). 308 references. (auth)

41281 TEMPERATURE STABILITY OF CaF_2:Mn AND LiF(TLD-100) THERMOLUMINESCENT DOSIMETERS. Gorbics, S. G.; Attix, F. H.; Pfaff, J. A. (U. S. Naval Research Lab., Washington, D. C.). Int. J. Appl. Radiat. Isotop., 18: 625-30 (Sept. 1967).

Thermoluminescent dosimeters containing LiF(TLD-100) and others containing CaF_2:Mn were studied to determine the influence of ambient temperature, both during γ-irradiation and during later storage, upon the thermoluminescence response. It was found that the response is unaffected by the temperature during irradiation from −50°C (the lower limit studied) up to the temperature where trap leakage (i.e. signal fading), becomes significant. The results obtained for LiF(TLD-100) fading were consistent with those reported by Zimmerman et al. (Health Physics 12, 525, 1966). (auth)

41282 STUDY OF ELEMENTARY PARTICLE INTERACTIONS FOR HIGH-ENERGY DOSIMETRY. Katoh, Kazuaki (Japan Atomic Energy Research Inst., Tokyo); Turner, J. E. Health Phys., 13: 831-43(Aug. 1967).

Types of interactions are classified and discussed from the standpoint of their relative importance in the dosimetry of particles with energies up to several tens of GeV. The known elementary particles are treated individually and threshold energies, cross sections, and important reactions leading to their production and absorption are given. The principal reactions by which these particles can contribute to dose and dose equivalent are described. The data reviewed and summarized are intended to provide a starting point for detailed calculations or analyses of dose from high-energy particles. (auth) (UK)

41283 ALL-STATE FILM-DOSIMETRY SERVICE IN CSSR. PART I. BASES OF FILM-DOSIMETRY AND METHODS OF MEASURING DOSES. Trousil, Jaroslav; Bucina, Ivan (Inst. for Research, Production, and Application of Radioisotopes, Prague). Jad. Energ., 13: 321-6(Sept. 1967). (In Czech).

The method of measuring personal doses of gamma-, beta- and x-rays in the range of 20 mR to 1000 R by means of film-dosimetry method is described. The first part concisely introduces the bases of film dosimetry, especially with regard to an energy dependence of efficiency of photographic emulsion and methods of its compensation. Used dosimeter films, film-holders and methods of measuring doses are also described. The method of correction of energy dependence of dosimeter films for gamma- and x-rays in range of 10 keV to 3 MeV and for beta-rays in range of 0.4 or 0.7 MeV to 3.5 MeV is presented. The way of measuring optical densities of films in range of D = 0 to D = 6 and the method of calibration of film-badges are described. (auth)

41284 EXPOSURE METER MERIC. Tanaka, Osamu; Horie, Kazuo (Mitsubishi Electric Corp., Japan). Mitsubishi Denki Lab. Rep., 41: 829-33(June 1967). (In Japanese).

An exposure meter (MERIC) employing ionization chambers and having the exposure rate ranging from 1,000 R/min to 100,000 R/min of x-ray and gamma-ray was developed. For the measurement of the exposure rate of high-intensity pulsed radiation generated by the electron linac and the betatron, the indications of conventional chambers do not give linear behavior, while MERIC provides better linearity for it. This has resulted from fundamental improvements on the ionization chamber and the input circuit. MERIC is available as a radiation monitor in the fields of such a variety as prevention of germination and sterilization of grain or other foods; medical treatment, sterilization of medical appliances, and production of chemicals. (auth) (NSA of Japan)

41285 ABSORBED DOSE MEASUREMENT BY FLUORO-GLASS DOSIMETER. Yokota, Ryosuke; Nakajima, Saburo (Tokyo Shibaura Electric Co., Ltd.). Oyo Butsuri, 36: 452-5 (June 1967). (In Japanese).

Solid state Bragg–Gray cavity chamber is developed in which thin plates with various thickness of low-Z silver-activated phosphate glass are used as cavity solid. The method of measurement is improved. After some theoretical considerations, this method is verified to be useful by the experiments. With this method the absorbed dose of the wall material can be measured. Minimum measurable dose is 0.1 rad. (auth) (NSA of Japan)

41286 A CdS DOSEMETER FOR PHANTOM AND INTRA-CAVITARY MEASUREMENTS. Kunze, J.; Gnauck, C. (VEB Vakutronik WIB, Dresden). Kernenergie, 10: 220-2(July 1967). (In German).

A measuring device is described allowing the determination of dose rates of penetrating ionizing radiation. A CdS cell (with permanent pre-excitation for diminishing the time constant) is used as the radiation detector, the electrical resistance of which varies with radiation intensity. The cell is placed in a catheter probe of small diameter which is connected to a handy radiation meter by a flexible cable. The radiation meter includes a pointer instrument and a relatively simple wiring, the essential components of which are the measuring and the compensation circuits. For gamma and x-ray radiation dose rates of about 1 to 3000 R/h can be determined. (auth)

Radiometric Instruments

Refer also to abstracts 40997, 41161, 41165, and 41186.

41287 KIT ASSEMBLING SYSTEM OF A RADIOISOTOPE INSTRUMENT WITH PULSE SCANNERS UTILIZED FOR INDUSTRIAL MEASUREMENT AND CONTROL. Mickovsky, Miloslav. Jad. Energ., 13: 301-7(Aug. 1967). (In Czech).

Descriptions are given of the design and performance of radiometric level indicator with pulse-transducers developed at the Tesle-Liberec plant laboratory. The device will be ready for commercial production in the second half of 1967. (tr-auth)

41288 NEUTRONOGRAPHICAL INSTALLATION ON THE THERMAL WWR-S COLUMN. Khrushchev, B. I.; Bogomolov, A. M.; Sharipova, L. S. (Tashkent State Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 4, 108-12(1967). (In Russian).

Descriptions are given of a neutron diffraction camera for a WWR-S thermal column capable of recording liquid metal diffraction pictures at angles of 0 to 100° and in the range from room temperature to 1600°C. (tr-auth)

Miscellaneous Instruments and Components

Refer also to abstracts 41094, 41892, 41919, and 42479.

41289 (AERE-R-5021) CALCULATION OF NOISE/SIGNAL RATIO OF A NUCLEAR PULSE AMPLIFIER EMPLOYING GATED ACTIVE INTEGRATION. Deighton, M. O. (Atomic Energy Research Establishment, Harwell (England)). May 1967. 55p. Dep. CFSTI, UK 8s.

A method of calculating noise in pulse-amplifying systems, such as those employed in nuclear pulse spectrometry, is presented. The method is time-domain and is thus specially suitable for cases where the pulse processing involves a mixture of analogue and digital techniques (e.g., gating, active integration, etc.). It also has positive advantages when applied to certain more conventional arrangements, for example, those employing single or multiple delay-line shaping. The detailed analysis given is an example of its application to active integrator systems, as proposed by Kandiah. Two types of integrator are analysed, in one of which the CR coupling time constant is switched. The latter system, with proper choice of parameters, yields a noise/signal ratio only 1.6% greater than the ideal cusp-response amplifier. Results are presented in the form of noise maps for each of five versions of the active integrator; for comparison the noise map of a conventional single-CR amplifier is also included. (auth)

41290 (BNWL-SA-1227) THERMOCOUPLE DEVELOPMENT FOR THE FAST FLUX TEST FACILITY. Huck, C. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug. 21, 1967. Contract AT(45-1)-1830. 11p. (CONF-670903-11). Dep. CFSTI.

From 22nd Instrument-Automation Conference and Exhibit, Chicago, Ill.

Twenty-four thermocouples of various types were assembled into two fuel pin-size capsules, BT-1 and BT-2, and are now being exposed to a neutron flux density level of about 10^{15} nv in EBR-II. The purpose of the tests is to determine the effects of exposure of several types of thermocouples to fast neutron fluences of about 3×10^{22} nvt, along with the concurrent effects of high temperatures and high gamma radiation fields expected to be encountered in about one year of FFTF operation. Chromel/Alumel, Geminol-P/Geminol-N, platinum/platinum-10% rhodium, tungsten/tungsten-26% rhenium, and tungsten-5% rhenium/tungsten-25% rhenium thermocouples are included in these tests. Prior to insertion in EBR-II, the thermocouples were subjected to a series of laboratory materials verification, response time, and emf calibration tests. The response time and calibration

tests will be repeated in a hot cell after irradiation to determine transmutation and other effects occurring from irradiation in the reactor. The Chromel/Alumel and Geminol thermocouples are candidate thermocouples of interest for FFTF sodium coolant temperature measurements. The platinum and tungsten alloy thermocouples were included primarily because of availability for the early development of laboratory and hot cell handling techniques. (auth)

41291 (EUR-3551,e) WINDOW DISCRIMINATOR WITH TUNNEL DIODES. Sattler, E. (European Atomic Energy Community, Geel (Belgium). Central Nuclear Measurements Bureau). Aug. 1967. 28p. Dep.

A window discriminator was developed using tunnel diodes as threshold stages. The window width is variable between 10 and 210 mV for a range of the base line threshold level from 10 to 210 mV. The thresholds remain constant for a given dial setting down to a pulse width (fwhm) of 5 ns. The discriminator output pulses can be used for timing to a certain extent, because of the constant time interval between the lower threshold trigger and the output of the discriminator due to utilization of leading edge trigger technique. The propagation delay jitter is only determined by the dynamic range of input pulse amplitudes and rise times. Quenching circuitry is provided to allow faultless operation of the realized unit for high pulse rates and for high overload factors. The general characteristics and physical dimensions of the discriminator conform to the ESONE rules. (auth)

41292 (NP-16972) ANNUAL REPORT OF THE DEPARTMENT OF ATOMIC ENERGY, GOVERNMENT OF INDIA, 1966-67. (Department of Atomic Energy, Bombay (India)). 74p. Dep.

The reactors Apsara, Circus, and Zerlina were fully utilized for research and isotope production at the Bhabha Atomic Research Center (BARC). Other activities at BARC include preparation of Pu-Be neutron sources, development of plasma guns, basic physics research, development of nuclear instruments and radiation detectors, production of U, production of heavy water, fuel processing, waste management, research on actinide elements, and medical and biological research. Activities at the Tata Institute include mathematics research, research on particle physics, computer development, studies of angular correlations of radioactive nuclei, NMR studies of liquid metals, semiconductors, and rare earths, investigations of cosmic radiation, geophysics research, radioastronomy investigations and research on molecular biology. Activities at other research institutions are briefly summarized. (J.R.D.)

41293 (SCL-DC-67-92) AN ETCHED MANGANIN GAGE SYSTEM FOR SHOCK PRESSURE MEASUREMENT IN A HIGH NOISE ENVIRONMENT. Williams, Edward O. (Sandia Corp., Livermore, Calif.). Aug. 1967. Contract AT(29-1)-789. 9p. (CONF-670903-12). Dep. CFSTI.

From 22nd Instrument-Automation Conference and Exhibit, Chicago, Ill.

Several innovations which allow manganin gages to be used for shock pressure measurements in high noise environments, such as those containing radiation and electromagnetic effects, are described. The etched manganin gage, which is noninductive, is an active 50-ohm grid 0.00075 inch thick with an area of 0.06 square inch. One or more gages may be placed internally in a conductive or nonconductive sample to measure shock speed and attenuation at the desired depth or depths. In present applications, the gage is used to measure shocks with amplitudes ranging from 1-50 kilobars and durations of several microseconds. The associated electronic system is capable of providing a frequency response of 15 megahertz through a 50-ohm coaxial cable several thousand feet long. The powering system contains a limiter follower to prevent electronic overloads with a minimal change in terminal impedance. (auth)

41294 (UCRL-17583) LIGHT AMPLIFICATION BY SHORT-PULSE IONIZATION IN A GAS. Miller, Harold William (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 1966. Contract W-7405-eng-48. 76p. Dep. CFSTI.

Thesis.

An optical image amplifier capable of producing a photographable image due to a single photoelectron leaving its photocathode would be a useful device. The basic processes of electron-avalanche development in an inert gas with nanosecond pulsed electric fields are studied and the possibility of using electron avalanches to provide optical gain in an image amplifier are investigated. Experimentally it is shown that optical gains as high as 2×10^7, with an image resolution of 0.5mm, could be obtained using the controlled electron avalanche principle. The resolution is limited by the avalanche diameter which at lower gains than cited above can be less than .1mm. (auth)

41295 TRANSISTORIZING MODULAR NUCLEAR INSTRUMENTS. Volly, Laszlo Finommechanika (Hungary), 5: 249-53(Aug. 1966). (In Hungarian).

So far the Optical Research Laboratory developed the following modules: linear pulse amplifier, differential discriminator, linear ratemeter, high-voltage power supply, counter, preselecting counter, precision time base generator, printout recorder, and compensograph. The efforts for transistorizing modular nuclear instruments were described. The subject of reliability was discussed and accelerated exposure tests were described. Finally, a complex instrument consisting of a nuclear transducer, parameter selector, linear pulse amplifier, precision counter, time base generator, and rapid printout recorder, used as a channel automatic amplitude analyzer, was described. (ATD)

41296 NOISE-LEVEL POWER EQUIVALENTS OF SOME PHOTOELECTRON MULTIPLIERS. Liyva, A.; Il'ves, E.; Punning, Ya.-M. (Inst. of Zoology and Botany, Academy of Sciences, Estonian SSR). Izv. Akad. Nauk Est. SSR, Ser. Fiz. Mat. Tekh. Nauk, No. 1, 88-93(1966). (In Russian).

The Institute of Zoology and Botany, Academy of Sciences Estonian SSR, introduced new noise-level testing techniques for individual selection of photoelectron multipliers, in order to minimize the noise present in measuring instruments which record soft, low-energy beta radiation, with particular emphasis on scintillation counters, whose sensitivity depends on the noise generated by the multipliers. Since the noise levels of these multipliers vary considerably even within a single production lot, it is emphasized that the selection should be individual. The multipliers were tested for power equivalents of noise levels, noise level dependence on multiplier voltage, and noise spectra. All measurements were made with the use of a single-channel scintillation counter. Power-line voltage stabilization was achieved by using an electronic stabilizer. The characteristics and parameters of the multipliers tested, and the noise-level voltage minima are presented in tabulated form. (JPRS)

41297 THE DESIGN AND EVALUATION OF A FAST-RESPONSE MASS SPECTROMETER AND THE EFFECT OF LOW-TEMPERATURE CATHODES ON THE ION SOURCE PERFORMANCE. Steckelmacher, .; Evans, S.; Collins, R. (Edwards High Vacuum International Ltd., Manor Royal, Eng.). Nuovo Cimento (1), Suppl., 5: 224-33(1967).

A small sector-field mass spectrometer specifically designed for residual gas analysis and incorporating a particle multiplier, which has a high intrinsic sensitivity even under fast-scanning conditions, is developed. Noise and response time limitations are reduced by several decades, the main limitation being statistical noise arising from the corpuscular nature of the ion beam itself. Also the separation of the ion source from the analysis system allows the use of nude sources for immersion in the residual gases to be analyzed. A thermionic emitter, electron-collision-type ion source was also constructed as a subassembly on a small demountable flange. (J.F.P.)

41298 NEW SHUTDOWN AMPLIFIER (S.D.A.) FOR NUCLEAR REACTORS. (PART 2). Morris, I. G. Electron. Eng., 39: 553-7(Sept. 1967).

Some of the aspects considered during the design of the various circuit elements, in order to provide equipment with optimum fail-safe properties without impairing its operation or building in too many redundant components, are discussed. (auth)

41299 ELECTRON BEAM PROFILE INDICATOR. Kalibjian, R.; Tindall, W. E. (Univ. of California, Livermore). J. Sci. Instrum., 44: 800-1(Sept. 1967).

An automatic plotter was developed in order to determine the current density profile of electron beams in the 10-200 V range. The system consists, basically, of a matrix collector, scanned by a stepping relay. (auth)

41300 INSTRUMENTATION FOR RECEIVING ELECTROMAGNETIC NOISE BELOW 3,000 CPS. Lokken, J. E. (Defence Research Board of Canada Esquimalt, British Columbia). pp 373-428 of Natural Electromagnetic Phenomena Below 30 kc/s. Bleil, D. F. (ed.). New York, Plenum Press, 1964.

From NATO Advanced Study Institute, Bad Homburg, Ger., July 22-Aug. 2, 1963. See CONF-630703.

Factors affecting the design and siting of systems for receiving electromagnetic noise are discussed. Information is presented on the design of the following: proton precession magnetometer, frequency multiplier and phase-locked filter, rubidium magnetometer using swept-field frequency locking, self-oscillator magnetometer employing a single cell and a single light path, dual cell self-oscillation magnetometer, crossed-beam self-oscillator magnetometer, metastable helium magnetometer, peak voltage magnetometer, magnetometer with feedback and bias, tuned inductor

magnetometer employing feedback, pulse fluxgate magnetometer, Grenet induction variometer, frequency-multiplex tape recording system, Pacific Naval Laboratory elf system, Byrd and Pole Station whistler recorders, and vlf spectrum measurement equipment at Byrd Station. (J.H.M.)

41301 FAST SCANNING MASS SPECTROMETER. Kondo, Toshio; Watanabe, Kazuo (Hitachi Ltd., Tokyo). Shitsuryo Bunseki, 14: 257-64(Dec. 1966). (In Japanese).

The ion detector for a fast scanning mass spectrometer was developed. The instrument used in a Hitachi mass spectrometer: modified RMU-6D, of a single focusing, 90° sector type. A mass range of mass/charge 10–500 may be magnetically scanned in 3 seconds: the peaks are recorded on strip chart of a recording galvanometer. The ion detector is described which incorporates an electron multiplier and a fast response electrometer. The electron multiplier consists of 10 stage Ag–Mg dynodes. The electrometer has the feedback resistor surrounding a metal sleeve which is connected the output of the amplifier through a PID network and the response speed is increased. The response and the noise of the ion detector are discussed. Design procedures led from the discussion and the complete circuits are given. The ion detector can be used in measurement of current from 2.5×10^{-11} to 1×10^{-14} amperes and the 90% initial response is 40 microseconds. (auth) (NSA of Japan)

41302 CHANNEL ELECTRON MULTIPLIER, A NEW RADIATION DETECTOR. Adams, J.; Manley, B. W. (Mullard Research Labs., Surrey, Eng.). Philips Tech. Rev., 28: 156-61 (1967).

A channel electron multiplier, which is a distributed dynode multiplier that combines the functions of the dynode structure of the conventional photomultiplier and the resistor chain which divides the potential among the separate dynodes, is described. (B.G.D.)

41303 RADIOACTIVE DISPERSIONS FOR RADIOACTIVE ABLATION SENSORS. Florentine, Robert A.; Schneider, J. F.; Gicking, D. S. (General Electric Co., Valley Forge, Pa.). J. Spacecraft Rockets, 4: 1083-4(Aug. 1967).

In order to achieve slender re-entry vehicles the designers of heat production systems have been relying on the performance of radioactive ablation sensors. One such ablation sensor was fabricated containing a low percentage of refractory material (hafnium carbide) for installation in the shield of a space vehicle. Hafnium-181 which is contained in the refractory material and which emits a characteristic gamma spectrum was monitored and as ablation occurred the activity changed. The uniformity with which hafnium carbide was dispersed throughout the sensor was also investigated. (B.G.D.)

41304 VOLTAGE STABILIZER FOR NUCLEAR ELECTRONIC MODULAR SYSTEMS. Sebestyen, Bela. ATOMKI (At. Kut. Intez.) Kozlem., 9: 43-7(June 1967). (In Hungarian).

The description of a voltage stabilizer combined with a converter is given. The circuit was made for a nuclear electronic modular system. The power supply has four independent outputs of voltage 2×6 V each. By connecting the outputs in series the supply unit furnishes the output voltages ±6, ±12, ±18, ±24 V. (auth)

41305 NUCLEAR MAGNETIC RESONANCE FIELD DISCRIMINATOR USING DIGITAL TECHNIQUES. Reimann, Richard (Federal Inst. of Tech., Zurich). Z. Angew. Math. Phys., 18: 549-56(July 25, 1967).

A new NMR field discriminator is described with a linear operating range which depends only upon the amplitude of the magnetic field modulation. As a spin detector a Pound–Knight marginal oscillator is employed whose frequency is determined by a crystal stabilized oscillator. Instead of the usual absorption signals, dispersion signals are used which are converted to narrow pulse signals by a Schmitt trigger. Information about the field deviation is obtained from the time sequence of the resonance signals. (W.H.K.)

41306 POLUPROVODNIKOVYE SKHEMY NANOSEKUNDNOGO DIAPAZONA V YADERNOI ELEKTRONIKE. VYPUSK I. (A Nanosecond Range Semiconductor Devices in Nuclear Electronics, Volume 1). Tsaregorodtseva, M. N. (ed.). Moscow, Atomizdat, 1967. 72p.

Four articles are included on the design and performance of nanosecond-range measuring and recording devices used in experimental nuclear physics. Pulse amplifiers, linear pulse gating, amplitude discriminators and designs of linear and nonlinear nanosecond pulse summation are briefly reviewed. (R.V.J.)

Radiation Effects on Instruments and Instrument Components

41307 RADIATION EFFECT ON MOS DEVICES. Glotin, Ph. (CEN, Grenoble, France). Onde Elec., 47: 950-3(July-Aug. 1967). (In French).

The present state of knowledge concerning the effects of radiations on metal-oxide-semiconductor devices is summarized. The interest of using such components in space circuitry is first shown. The behavior of electric characteristics degradations under radiation is analyzed and the variation of the turn on threshold voltage is specially looked after. From these experimental results, a tentative physical explanation of the phenomena is proposed, based on ion displacements in the oxide during irradiation. Special experiments are indicated to verify this theory. In conclusion, the possibilities of using MOS transistors in a radiative environment are reviewed. (auth)

41308 THE EFFECTS OF ^{60}Co GAMMA RADIATION ON MOS DIODES. Mattauch, R. J. (Univ. of Virginia, Charlottesville); Lade, R. W. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: No. 4, 52-7(Aug. 1967).

MOS diodes were fabricated on silicon substrates and exposed to ^{60}Co gamma radiation. A change in both surface state density and oxide charge density was noted. Nonirradiation annealing studies were carried out to determine the nature of the oxide charge. It was deduced on the basis of annealing data that the oxide charge was due to mobile alkali ions. The radiation was seen to cause a decrease in the oxide charge density. A model attempting to explain this change was fabricated assuming Compton scattering in the oxide. The change in semiconductor surface charge density caused by the gamma irradiation was found producible or reversible by means of elevated temperature, applied bias annealing. (auth)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstracts 40799, 41384, 41390, and 41427.

41309 (ACRH-1000-13) ERYTHROPOIETIN, ITS NATURE AND MECHANISM OF ACTION. Dukes, Peter P. (Argonne Cancer Research Hospital, Chicago, Ill. Chicago Univ., Ill. Dept. of Biochemistry). Mar. 1967. Contract AT(11-1)-69. 23p. (CONF-670421-1). Dep. CFSTI.

From 18th Annual Mosbach Colloquium, Mosbach, Germany.

A review of recent literature on erythropoietin, is presented. Studies on the chemical nature, purification, and in vivo and in vitro assays are discussed. Experiments on the incorporation of ^{14}C-glucosamine into bone marrow cells are reviewed with regard to the following aspects: specificity, glucose labeling, dose response, time course, and inhibitor studies. (H.L.W.)

41310 (AD-645204) THE INFLUENCE OF SOME HEXITOLS AND SUGARS ON CO_2 PRODUCTION BY STARVED AND X-IRRADIATED, STARVED YEAST CELLS. Spoerl, Edward S.; Doyle, Ronald J. (Army Medical Research Lab., Fort Knox, Ky. Biophysics Div.). Sept. 27, 1966. 17p. (USAMRL-682). CFSTI.

Incubation of x irradiated and nonirradiated yeast cells in solutions of mannitol, ribose, methyl glucose, or cellobiose maintained equivalent rates of CO_2 production by the two cell types. Output was measured with glucose as the substrate. A relatively higher rate of CO_2 output by irradiated cells was observed after a 21 hour incubation in water. Incubation of the cells with the above compounds also eliminated a lag period in CO_2 output and preserved a high capacity to produce CO_2. Incubation with glucose or fructose lowered the rate of CO_2 output and did not eliminate the difference in output between irradiated and unirradiated cells. Conversion of cells to spheroplasts also eliminated the radio-induced difference in the rate of CO_2 production. Reincubation, after a 21 hour starvation in water, with any of the compounds tested removed the lag period, though CO_2 output was reduced. (CFSTI)

41311 (AD-648964) ATTEMPTS TO TRANSFER MYELOMA GLOBULIN SYNTHESIS WITH RNA. III. IMMUNOLOGICAL ANALYSES OF PROTEIN PRODUCTS. Chin, P. H.; Silverman, M. S. (Naval Radiological Defense Lab., San Francisco, Calif.). Feb. 7, 1967. 47p. (USNRDL-TR-67-17). CFSTI.

Lymphoid cells from normal C3H mice were pretreated with protamine sulfate and incubated in vitro with RNA isolated from a C3H plasma cell tumor. The RNA-treated cells were subsequently injected into sublethally irradiated isogenic recipients or cultured in vitro in medium containing C14-L-leucine. In spite of the greatly enhanced uptake of exogenous RNA by lymphoid cells after treatment with protamine sulfate, induced synthesis of myeloma globulin could not be demonstrated when the cells were cultured either in vivo or in vitro. Electrophoretic analyses of sera obtained from recipient mice showed in a few instances the presence of a serum component that had the same electrophoretic mobility as the gamma myeloma protein. However, immunoelectrophoretic and double diffusion tests provided no evidence for the presence in the experimental sera of proteins having the specific antigenic characteristics of the tumor protein. Similarly, although radioimmunoelectrophoretic analyses of extracts from RNA-treated cells cultured in vitro indicated de novo synthesis of globulins, no reaction was observed when the globulins were reacted with specific anti-myeloma globulin antiserum. The inability of RNA to transfer information for myeloma globulin synthesis appeared to be due to the rapid and practically complete quantitative intracellular degradation of the RNA of exogenous origin observed within 24 hours after uptake. Results strongly suggested that RNA per se did not transfer information for antibody synthesis. (auth)

41312 (COO-1485-14) USE OF A TRACE ELEMENT IN STUDYING THE MOVEMENTS OF SOME SMALL MAMMALS. Lane, Robert H. (Bowling Green State Univ., Ohio). June 1967. Contract AT(11-1)-1485. 47p. Dep. CFSTI.

Thesis.

The workability of a new technique using the non-radioactive trace element rubidium to determine movement patterns of some small mammels (Rattus rattus and Rattus exulans) was tested. The study was conducted on the Eniwetok Atoll, Marshall Islands, United States Trust Territory of the Pacific. Two application methods were tried: a foliar spray and an impregnated bait. The rubidium concentrations acquired by the rodents were determined from subsequent tissue analyses by atomic absorption spectrophotometry. The amount of rubidium absorbed by plants was dependent upon the hydration and evapotranspiration but the loss-rate was not. The half-loss time (time needed for initial concentration to decrease by half) was much shorter for dicots than for monocots. In plant and animal tissues, the average background rubidium concentrations (by weight) were 7.8 ppM for plants and 26.5 ppM for rats. The rodents that ingested the rubidium baits or treated vegetation were easily detected and had concentrations ranging from 35.4 to 3420 ppM, by weight. No correlation was found between the acquired rubidium concentrations in rats and their capture distance from the rubidium source. The technique, which is workable, had some disadvantages such as individual marking difficulties and identification upon death only. Some of the distinct advantages of the technique are the ease of handling, application, and its definitive identification. (auth)

41313 (AERE-R-3860) SOME EFFECTS OF IONIZING RADIATION ON AQUEOUS SOLUTIONS OF β-LACTOGLOBULIN. I. THE INFLUENCE OF SOLVENT, pH, PROTEIN CONCENTRATION AND TEMPERATURE. Glew, G.; Hansen, P. I.; Smyth, P. M.; Laws, J. F.; Ley, F. J. (United Kingdom Atomic Energy Authority, Wantage (England). Research Group). Dec. 1961. 18p. Dep.

Solutions of β-lactoglobulin were irradiated under a variety of conditions and certain changes in viscosity, solubility, uv absorption and -SH and S-S concentration have been measured. At the dose levels studied, radiation caused an initial increase in viscosity, reduced solubility at pH 2.0, increased uv absorption and decreased both -SH and S-S concentration. When the protein was irradiated in two different buffers at the same molarity the same decrease in solubility was observed yet irradiation in the same buffer at different molarities caused a different degree of change. The dilution effect was demonstrated showing that the number of molecules damaged by unit dose is independent of concentration and that changes in the molecules are caused by the indirect action of radiation. No difference in the effect of radiation on solubility at pH values of 8.0 and 2.0 was observed, whereas irradiation at pH 5.0, near the isoelectric point, caused precipitation of the protein. With regard to the effect of radiation on the –SH concentration it was found that the lower the pH the less was the change. These pH effects can be attributed to the presence of radicals of varying reactivities at different pH values. Temperatures between 0° and 30°C did not influence the effect of radiation on solubility or –SH and S-S concentration yet irradiation in the frozen state (–10°C) showed a marked protective effect on these criteria of change. (auth)

41314 (LFEN-57) INTERFERENCIA DAS RADIACOES NA ACTIVIDADE CUPRO-OXIDASICA DO SORO HUMANO. (Radiation Effects on the Copper Oxidation in Human Serum). Galvao, J. P.; Magalhaes, E. M.; Teixeira, F. P.; Matos, M. H. (Junta de Energia Nuclear, Sacavem (Portugal). Laboratorio de Fisica e Engenharia Nucleares). 1966. 14p. (In Portuguese). (CONF-650986-1). Dep.

From 10th Brazilian and 1st Portuguese Congress on Radiology, Rio de Janeiro, Brazil.

Various investigators have observed that the effect of ultraviolet radiation on human serum causes a lowering of its oxidase activity when in the in vitro presence of paraphenylendiamine. The Ravine method under radioactivation of serum Cu with neutrons was used to determine a possible ionizing radiation effect. Human serum was exposed to γ and x radiation. The analyses showed that the different protein fractions of the serum contained Cu. It was verified that γ and x radiation modified the oxidizing activity in human blood. (tr-auth)

41315 (NP-16794) PREMIER SUJET. ABSORPTION ET TRANSPORT DU ^{45}Ca CHEZ LE THUYA. DEUXIEME SUJET. ETUDE BIBLIOGRAPHIQUE DE L'ABSORPTION RADICULAIRE ET DE LA TRANSLOCATION. (Part I. Absorption and Transport of ^{45}Ca by Thuja. Part II. Bibliographic Study of the Radicular Absorption and Translocation). Perret, Therese (Grenoble Univ. (France). Faculte des Sciences). Oct. 19, 1965. 46p. (In French). Dep.

Thesis.

The absorption and transport of ^{45}Ca by Thuja was studied in order to determine with the greatest precision possible the period of absolute dormance of the tree and the time lapse during which the foliar test can not be practiced on this tree. The cultivation method used for the trees and the experimental techniques are described. The principle of the counting method is given. The data showed that

the foliar test in the case of Thuja is unusable from mid-October to the beginning of March, the period covering the absolute dormance and a part of the postdormance during which the transports are very slow. A contamination during the winter can be detected at the time of awakening as a new distribution of the mineral matter accumulated in the roots occurs during the period of dormance. At all seasons Thuja can show radioactive contamination by its root system if the tree is killed. A bibliographic study is presented of the radicular absorption and translocation in trees. (J.S.R.)

41316 (STI/PUB-137) ISOTOPES IN PLANT NUTRITION AND PHYSIOLOGY. Proceedings of the Symposium Held in Vienna, 5-9 September 1966. Proceedings Series. (International Atomic Energy Agency, Vienna (Austria)). Feb. 1967. 611p. (In several languages). (CONF-660912). IAEA: $12.50; Australian Schillings 323,-; Pound 4.8.4; F Fr 61,30; DM 50,-.

Separate abstracts were prepared on 10 papers. Thirty-five additional papers discuss various aspects of soil chemistry and fertility, transport phenomena, assimilation and metabolism, ion absorption, accumulation and transport, genetic aspects of plant nutrition, and experimental techniques. (E.R.B.)

For abstracts of individual papers see: 40779, 41340–41347, and 41410.

41317 EFFECTS OF RADIATION ON ANTIBODY FORMATION. CURRENT VIEWS. Nossal, G. J. V. (Walter and Eliza Hall Inst. of Medical Research, Melbourne). At. Energy Rev., 5: 3-41(Apr. 1967).

Recent studies (171 references) on the effects of radiation on the immune response are summarized, and an analysis is made of the different ways in which the irradiated animals are used as a tool in immunological investigations. The effect of radiation on antigen-capturing mechanisms is examined, with special reference to the behavior of antigen-retaining cells in the lymphoid follicles. The conclusion is reached that whole-body irradiation has previously unsuspected effects in reducing antigen capture in these areas of the lymphoid tissue, and that this effect may be due to a lowering of opsonin levels. Some experiments are cited on the effects of radiation on macrophage lymphoid interactions but the conclusion is reached that such effects are not yet fully established. The genesis of immunocompetent cells is analyzed in depth, and the respective roles of the bone marrow, the thymus and the recirculating pool of antigen-reactive cells in peripheral lymphoid tissue are dissected. Many examples are given which show how important radiation studies have been in clarifying our concepts on these major compartments in the immune system. Brief reference is made to the importance of the timing of irradiation in assessing damage to antibody production, and to studies on the restoration of radiation damage. A fuller analysis is made of the cellular kinetics of antibody formation, with special reference to the histological nature of antibody-forming cells and to feed-back and other controlling mechanisms. The effects of radiation on the state of immune tolerance are examined, with special reference to the new concept of two zones of antigen dosage capable of inducing tolerance, and to the finding that x-irradiation can under some circumstances help the induction of tolerance and under other circumstances actually accelerate the breakdown of tolerance. Finally, the impact of these studies on current theories of antibody formation is summarized, and the conclusion is reached that present evidence favors selective rather than instructive theories of antibody formation. (auth)

41318 THE ROLE OF LYMPHOCYTES IN ANTIBODY FORMATION. II. THE INFLUENCE OF LYMPHOCYTE MIGRATION ON THE INITIATION OF ANTIBODY FORMATION IN THE ISOLATED, PERFUSED SPLEEN. Ford, W. L.; Gowans, J. L. (Oxford Univ.). Proc. Roy. Soc. (London), Ser. B, 168: 244-62 (Sept. 12, 1967).

The aim of the studies described was to examine the possible immunological significance of the process of lymphocyte recirculation. For this purpose a technique for perfusing the isolated spleen of the rat was developed. Antigen (sheep erythrocytes) was added to the perfusate and, after 3 to 6 h periods of perfusion, the spleens were cut into fragments and implanted into the peritoneal cavities of X-irradiated syngeneic recipients to determine the magnitude of the haemolysin response. The lymphocyte concentration in the blood perfusing the spleen was varied within wide limits to determine whether a migration of lymphocytes through the spleen influenced its ability to respond to antigenic stimulation. Normal spleens perfused for 3 h with blood containing a normal concentration of lymphocytes gave substantial haemolysin titres in the recipients when sheep erythrocytes had been added initially to the perfusate. Spleens depleted of lymphocytes in vivo by either X-irradiation or chronic drainage from a thoracic duct fistula produced very low titres after perfusion with lymphocyte-free blood and antigen, but their responses were restored by adding lymphocytes to the perfusate. The antibody response of normal spleens was significantly depressed following perfusion for 3 h with lymphocyte-free blood to which antigen had been added initially. Normal responses were obtained, however, in this experiment if the addition of antigen to the perfusate was delayed for 5 h and perfusion then continued for one further hour. The delay allowed lymphocytes to migrate from the normal spleens into the perfusate and to build up the concentration in the initially lymphocyte-free blood to normal levels. The conclusion drawn from this paradoxical finding was that the magnitude of the haemolysin response depended upon the concentration of lymphocytes in the perfusate at the time of antigen addition and not upon the total number of lymphocytes in the spleen. The rate of migration of small lymphocytes from the blood into the spleen was found to be directly proportional to the concentration of lymphocytes in the perfusate. The most acceptable explanation of all the data is that the magnitude of the haemolysin response is proportional to the concentration of lymphocytes in a limited compartment of the splenic lymphoid tissue into which lymphocytes have recently migrated from the blood. This compartment is probably located in the central area of the periarteriolar lymphocyte sheath. (auth) (UK)

41319 PATTERN OF PLATELET DISAPPEARANCE. Murphy, Edmond A.; Robinson, G. A.; Rowsell, Harry C.; Mustard, James F. (Univ. of Guelph, Ont. Univ. of Toronto). Blood, 30: 26-38(July 1967).

Sulfur-35 and ^{32}P were used in pigs and in dogs for simultaneous tagging of platelets with cohort and population labels. The results suggest that platelet destruction is largely independent of platelet age. No evidence of endogenous platelet aging was encountered. The implications of these findings are discussed. It seems reasonable for the time being to use the exponential half-life as an index of platelet survival without committing oneself to the view that the exponential model adequately represents the phenomenon. (auth)

41320 THE EFFECT OF pH ON THE ^{36}Cl EFFLUX FROM FROG SKELETAL MUSCLE. Hutter, O. F.; Warner, Anne E. (National Inst. for Medical Research, London). J. Physiol. (London), 189: 427-43(Apr. 1967).

The efflux of ^{36}Cl and ^{42}K was measured in frog sartorii and toe muscles loaded in a 100 mM K 216 mM Cl solution at pH 7.4. The efflux of the isotopes into radioactive and inactive solution of the same composition at pH 5.0 and 9.8 was followed. Efflux of ^{36}Cl into acid solution was extremely slow so that the cellular fraction could easily be distinguished. On raising the pH the efflux of ^{36}Cl from sartorii increased 4.5 times, from toe muscles 6.7 times. The effect was fully reversible. Efflux of ^{42}K from sartorii was only slightly increased by alkaline solutions. When effluxes of ^{36}Cl and ^{42}K were measured simultaneously, the increment in ^{36}Cl efflux was much greater than the increment in ^{42}K efflux. Toe muscles depolarized by high K solution showed a two-fold increase in ^{42}K efflux on transfer from acid to alkaline solution. This effect was independent of the presence of Cl ions. The results confirm that Cl is the ion species principally concerned in the pH sensitivity of the membrane conductance. (BBB)

41321 ELECTRON IRRADIATION CHANGES IN LIPID LAYER SYSTEMS. Elbers, P. F. (Rijksuniversiteit, Utrecht). Curr. Mod. Biol., 1: 151-5(May 1967).

The effect of 80-KV electron irradiation on lipid layers was studied by electron microscopy, x-ray diffraction analysis, and ir absorption spectroscopy. Smaller layer spacings were found by electron microscopy than by x-ray diffraction. This was shown to be due to the ionizing effect of the electron bombardment, which caused bond rupture, cross linking, and loss of material in the molecules of the target. A comparison of the ir spectra of the intact and irradiated lecithin indicated changes in various functional groups of the molecules. The irradiated material gave an ir spectrum which differed from that of the control in the following general way: the band due to the carbonyl-group at 1739 cm^{-1} indicated double bond formation, the peaks due to CH_2 and CH_3 groups at 1470 cm^{-1} and 1380 cm^{-1} were flattened, and the two bands due to the phosphate group between 1300 and 1000 cm^{-1} were completely lost as were the bands due to skeletal vibrations between 1000 and 900 cm^{-1} and the small peak due to polymethylene chains at 720 cm^{-1}. (BBB)

41322 AN ELECTRON MICROPROBE STUDY OF RAT INCISOR TEETH WITH LOW OR HIGH CONCENTRATIONS OF STRONTIUM. Johnson, A. R. (Univ. of California, Los Angeles); Singer, Leon. Arch. Oral Biol., 12: 389-99(Mar. 1967).

This study reports the distribution of Sr, Ca, and P in enamel and dentin of rat incisor teeth as determined with the electron microprobe. Two groups of 21-day-old, male, weanling, Sprague-Dawley rats, weighing between 40 and 50 g were provided diets with different Ca and Sr contents. The low Sr diet contained 0.40% Ca, 0.0002% Sr, and 0.42% P. The high Sr diet contained 0.22% Ca, 0.45% Sr, and 0.41% P. These diets possessed essentially the

same molar quantities of divalent cation and P. The rats were maintained on these regimens for 43 days. The results showed that Sr produces decreased mineralization and that an inverse relation exists between Sr and Ca contents in the rat incisor tooth. Semiquantitative data on the Sr, Ca, and P contents of enamel and dentin are given. Sagittal sections of the high-Sr teeth revealed gradients of increasing Sr contents from the incisal to apical areas with P contents that were relatively constant. (BBB)

41323 QUANTITATIVE STUDIES ON MICROAUTORADIOGRAPHY OF TRITIUM-LABELED COMPOUND IN VIVO. III. AUTORADIOGRAPHIC DETERMINATION OF DNA SYNTHESIS PATTERN IN CELL CYCLE. Matsuzawa, Taiju; Hatakeyama, Tadashi (Tohoku Univ., Sendai). Nippon Igaku Hoshasen Gakkai Zasshi, 27: 117-21(May 1967). (In Japanese).

Since thymidine has been shown to be a specific precursor of DNA, the uptake of ^{3}H-thymidine into the cell nucleus was used as a measure of DNA synthesis pattern of ascites hepatoma 13R cells. After addition of ^{3}H-thymidine the ascites tumor cells were sampled almost at hourly intervals. The slides were dipped directly into NR-M2 liquid emulsion. For exposure the slides were stored in light tight boxes at 4°C during 20 days. The experimentally determined mean grain counts over metaphases for each successive hourly sample were plotted on a normal scale: DNA synthesis pattern of AH 13R cells showed asymmetric and upside down U shape on a normal scale: The curve facing G_2 phase ascended almost perpendicularly, and the one facing G_1 phase descended gradually making a prolonged S-shape. The imperfectional plateau was seen at the top of the curve; the duration of cell life cycle can be determined accurately on the curve; even if cell life cycle were changed, the amount of DNA synthesis kept a constant value; consequently DNA synthesis pattern in prolonged cell life cycle showed the prolonged asymmetric and upside down U shape. (auth) (NSA of Japan)

41324 QUANTITATIVE STUDIES ON MICROAUTORADIOGRAPHY OF TRITIUM-LABELED COMPOUND IN VIVO. I. PULSE LABELING OF ^{3}H-THYMIDINE. Matsuzawa, Taiju; Sasaki, Shinsaku (Tohoku Univ., Sendai). Nippon Igaku Hoshasen Gakkai Zasshi, 27: 105-11(May 1967). (In Japanese).

For the purpose of measuring the effective labeling time of ^{3}H-thymidine on ascites tumor cells, 100 μ Ci of ^{3}H-thymidine was injected intraperitoneally into each rat that was inoculated with 2×10^{6} Yoshida ascites tumor cells 3.5 days before examination. Ten rats used in this experiment were young Donryu rats weighing 78 ± 4 g. Animals were sacrificed with ether 5, 10, 15, 20, 25, 30, 40, 60, 90, and 120 minutes after ^{3}H-thymidine administration and whole ascites were washed out with cold saline immediately after sacrifice. Total tumor cells were counted by conventional hemocytometer, and total amount of ascites was estimated with mess-cylinder in each animal. The radioactivity of ascites, acid soluble fractions and DNA from the tumor cells were counted with Packard liquid scintillation counter. Meantime slides for microautoradiography were made from these ascites of each animal. The results were as follows: The duration of effective labeling time of ^{3}H-thymidine on Yoshida ascites tumor cells was approximately five minutes; administered ^{3}H-thymidine was rapidly incorporated into DNA through acid soluble fractions of the tumor cells, 40 minutes after administration ^{3}H-thymidine in DNA reached approximately maximum value which was $1/10$ of injected total ^{3}H-thymidine; the mean and standard deviations of ^{3}H-thymidine labeling index of Yoshida ascites sarcoma cells under described conditions were 61.0 and 1.7% respectively; proportional relations were recognized between grain counts and the radioactivity of DNA. (auth) (NSA of Japan)

41325 COMPARISON OF THE EFFECTS EXERTED BY LITHIUM ION ON THE INCORPORATIONS OF ACETATE-1-^{14}C AND MEVALONIC ACID-2-^{14}C INTO LIVER CHOLESTEROL. Leal, R. S. (Comissao de Estudos de Energia Nuclear, Lisbon). Rev. Port. Quim. (Lisbon), 8: 216-18(1966).

The effect of lithium ions on the incorporation of acetate-1-^{14}C and mevalonic acid-2-^{14}C by the cholesterol synthetic pathway was investigated. Using cultures of liver cells from adult female rats of the hooded Norwegian strain, it was shown that acetate-1-^{14}C incorporation into the cholesterol molecule was greatly reduced in the presence of lithium ions as compared to the amount incorporated in the presence of sodium ions. Incorporation of mevalonic acid-2-^{14}C, on the other hand, was virtually the same in the presence of either lithium or sodium ions. It was concluded that the effect of lithium ions was localized between acetate and mevalonic acid in the cholesterol synthesis pathway. (E.R.B.)

41326 QUANTITATIVE STUDIES ON MICROAUTORADIOGRAPHY OF TRITIUM-LABELED COMPOUND IN VIVO. II. CONFIDENCE LIMITS OF CELL CYCLE. Matsuzawa, Taiju; Hatakeyama, Tadashi (Tohoku Univ., Sendai). Nippon Igaku Hoshasen Gakkai Zasshi, 27: 112-16(May 1967). (In Japanese).

An autoradiographic study using ^{3}H-thymidine has been undertaken to investigate the confidence limits of cell cycle of actively proliferating Ascites Hepatoma 13R cells in the peritoneal cavity of the rats. Donryu rats weighing 126 ± 4g were used for this experiment. Tumor cells of 2×10^{5} were inoculated into each animal before preparation of slides for autoradiography. Nine cases among twelve which came successfully into pulse labeling were selected as experimental samples. After addition of ^{3}H-thymidine, the tumor cells were sampled almost at hourly intervals. The mean, the standard deviation, and the coefficient of variation (CV) of the generation time and the duration of M, G_2, S and G_1 phase are given. After administration of ^{3}H-thymidine the standard deviation of each point becomes larger with passing time; consequently the fiducial limits of G_1 phase become the lowest in those of cell cycle and every phase. The coefficient of variation of the first S phase is 3.3%, whereas that of the second S phase is 15.9%; the standard deviation of the second S phase is approximately five times larger than that of the first S phase. (auth) (NSA of Japan)

41327 EFFECTS OF THYROCALCITONIN ON BONE AND RENAL EXCRETION OF ^{45}Ca AND ^{85}Sr IN THE RAT. Mazzuoli, G. F.; Terrenato, L.; Coen, G.; Antonozzi, I. (Univ., Rome). Folia Endocrinol. (Pisa), 19: 7-12(Feb. 1966).

Experiments on thyrocalcitonin, a plasma calcium-lowering principle secreted by the thyroid, were conducted with rats. Results indicated that thyrocalcitonin lowered the plasma calcium level by inhibiting bone resorption. A decrease in urinary excretion of calcium and strontium also occurred. An effect on tubular calcium and/or strontium transport mechanisms was postulated. (H.L.W.)

41328 THE STRUCTURE OF THE URIDINE DIMER PRODUCED BY UV IRRADIATION OF URIDINE. Fahr, E.; Fuerst, G.; Doerhoefer, G.; Popp, H. (Univ., Wuerzburg, Ger.). Angew. Chem. Int. Ed. Engl., 6: 250-1(Mar. 1967).

Ultraviolet irradiation of uracil or thymine in an ice matrix affords dimeric pyrimidines that are of interest in the interpretation of biological radiation damage. Dimeric uridine, which is produced by uv irradiation of uridine, was isolated. The technique involved irradiating frozen aqueous uridine solutions (–5°C) with a low-pressure Hg lamp (Hanau NK 6/20). The products were separated by column chromatography and dimeric uridine appeared as third fraction, analytically pure: colorless crystals mp 178 to 179°C (from ethanol); molecular wt (cryoscopically and osmometrically in water) 480 (calculated 488). The structure was determined by degradation of the dimeric uridine with concentrated hydrochloric acid. Upon thin-layer chromatographic separation, uridine, uracil, and dimeric uridine were obtained, as well as the dimeric uracil. Contrary to expectation, the irradiation of uridine in an ice matrix leads to a dimer in which the sugar residues are oriented next to one another. (BBB)

41329 EFFECT OF HIGH DOSES OF IONIZING RADIATION ON PRESERVED HUMAN BLOOD. Varnai, F.; Lovanyi, I.; Janikovszky, B.; Ban, Ibola (Medical Postgraduate Inst. and Frederic Joliot Curie Research Inst., Budapest). Med. Pharmacol. Exp., 15: 198-202(1966). (In German).

Samples of preserved human whole blood were irradiated at 4 to 6°C with 5000, 10,000, 15,000, 20,000, or 30,000 R of x ray. The Ca concentrations increased to 20 or 22 meq by the first week postirradiation, to 28 to 30 meq by the second week, compared to 18 to 12 and 12 to 15 meq, respectively, in control samples. Even only 48 hr after irradiation with 30,000 R the Ca values were markedly greater than in the controls. However, the haptoglobin concentrations remained unchanged even when the Ca concentrations increased to from 25 to 37 meq following irradiation with 30,000 R. Toxicity tests in guinea pigs of the irradiated samples were negative. Fluorescence microscopy indicated an increase in green color of the thrombocytes in irradiated and in control bloods, with sharper contours and absence of group formation. There was a definite increase of plasma K values in the irradiated samples considering the lack of difference in haptoglobin levels; this indicated that this probably was not the result of hemolysis, but an injurious effect of the ionizing radiation on the cell membrane. These results suggested that in spite of the negative toxicity tests the irradiated blood could be used for transfusion only if the increased Ca levels were taken into account. (BBB)

41330 TRANSPORT OF RADIOACTIVE IODINE ^{131}I TO THE VAGINAL LUMEN AND GENITAL TRACT OF THE RAT. Gregoire, A. T. (Univ. of Michigan, Ann Arbor); Driscoll, D. H.; Adams, A.; Rakoff, A. E. Fert. Steril., 18: 303-8(May-June 1967).

Information concerning factors regulating transport of ^{131}I from the systemic circulation to the vaginal lumen was obtained

in Wistar rats. The animals were castrated at least 5 days before being treated with estrogen or progesterone. The estrogen-treated animals were given 5 μg of estradiol-17β intramuscularly for 3 days and the ^{131}I was administered on Day 4. The same method of treatment was used for the animals receiving 1 mg of progesterone daily. A 10-μCi dose of carrier-free ^{131}I was injected subcutaneously into the dorsal area of the animal, and vaginal fluid samples were obtained at 5 to 450 min later. The amount of radioactivity was expressed as a percentage of injected dose × 10^{-2}. The passage of the isotope to the vaginal lumen was rapid, and the difference between treatments were highly significant. The amount of vaginal fluid obtained from castrate or progesterone-treated castrate rats was greater than in those castrate animals receiving estradiol-17β. The passage of subcutaneously administered ^{131}I to the vaginal lumen decreased after estradiol administration. The uterus, cervix, and vagina of the rat genital tract concentrated radioiodine in greater amounts than either gut or muscle. (BBB)

41331 TRANSFERENCE TO EGG AND CHICK OF THE RADIONUCLIDES ^{89}Sr, ^{45}Ca AND ^{133}Ba WHEN ADMINISTERED TO LAYING HENS. Edwards, H. M. Jr.; Mraz, F. R. (Univ. of Georgia, Athens). Contract AT(40-1)-GEN-242. Poultry Sci., 40: 493-503(Mar. 1961).

After oral administration of 70 μCi ^{45}Ca, 35 μCi ^{89}Sr, and 21 μC ^{133}Ba to White Leghorn laying hens, large amounts of ^{45}Ca and ^{89}Sr were observed in the shell of eggs during the next few days. During this period the quantity of both in the shell was almost the same, while later, after 5 days, more ^{45}Ca than ^{89}Sr appeared. The quantity of ^{133}Ba appearing in the shell was considerably less than the other 2 radionuclides from day 1 through day 15. The ratio of the 3 radionuclides in the shell varied considerably, but the overall ratio was 4 : 2 : 1 for ^{45}Ca : ^{89}Sr : ^{133}Ba. This ratio especially between ^{45}Ca or ^{89}Sr and ^{133}Ba was much wider in the eggs laid shortly after dosing, probably as a reflection of the accumulative effects of various discriminating processes. Analysis of the quantities of radionuclides in the shell when the embryo had developed for 18 days and when the chick hatched at 21 days showed that there was no selection between the 3 radionuclides when Ca was withdrawn from the shell to the embryo. The quantity of ^{45}Ca and ^{89}Sr deposited in the yolk dropped off rapidly with time while the quantity of ^{133}Ba deposited in the yolk remained at a fairly high level, and even after 15 days 0.7% of the dose of ^{133}Ba was found in the yolk. Albumen of the unincubated egg contained a very small quantity of the radionuclides given, and differed from the yolk in that it contained a smaller amount of ^{133}Ba than of ^{45}Ca or ^{89}Sr. Also, the quantity of ^{133}Ba in the albumen decreased almost as rapidly as that of ^{45}Ca and ^{89}Sr. Data on bone and whole-embryo levels of the isotopes are also given. Various processes in the hen and in the embryonating egg apparently discriminate between these radioisotopes. The discrimination, in general, was in favor of Ca and Sr when the nuclides were deposited in a hard structure (bone and egg shell), while it was in favor of Ba when the nuclides were distributed in soft tissue. (BBB)

41332 EFFECT OF HYPOTHERMIA ON RADIOCALCIUM MOVEMENT IN CARDIAC MUSCLE. Guthrie, J. R.; Nayler, W. G. (Baker Medical Research Inst., Melbourne). Comp. Biochem. Physiol., 20: 657-65(Mar. 1967).

Ventricular muscle of toads (Bufo marinus) immersed in ^{45}Ca-containing Tyrode solution at 25°C consistently accumulated ^{45}Ca more rapidly than did paired preparations which were similarly bathed with ^{45}Ca-Tyrode solution at 4°C. Comparable results were obtained when quiescent and contracting preparations were used. When the amount of ^{45}Ca taken up by the 25°C preparations was compared with that which was taken up at 4°C, distinct phases of uptake emerged. The uptake of ^{45}Ca at 25°C could be represented by 2 separate curves, the first occupying the initial 10 min of incubation and the second between 15 and 30 min. Uptake of ^{45}Ca at 4°C could be represented as a single curve extending throughout the 30 min of incubation. The rate at which ^{45}Ca emerged from actively contracting preparations bathed with 25°C Tyrode solution consistently exceeded that at 4°C. Both the uptake and release of ^{45}Ca from quiescent and actively contracting muscle strips was enhanced if 5 mM caffeine was present. The effect of caffeine on the uptake and release of ^{45}Ca from toad ventricular muscle at 25°C was not significantly different from that at 4°C. (BBB)

41333 DETECTION OF DEPOSITS OF CALCIUM-STRONTIUM PHOSPHATE IN THE FRUIT STALK OF PISUM SATIVUM WITH THE X-RAY MICROANALYZER. Laeuchli, Andre (Univ., Basel). Planta, 73: 221-7(1967). (In German).

An x-ray microanalyzer was used for sensitive and localized detection of Sr and other mineral ions in cryostat sections of plant tissues. The principles upon which the instrument operates and the various methods used are described. During an investigation of Ca and Sr transport in plants to fruit and seed, microcrystalline deposits of Ca–Sr phosphate were demonstrated in the sclerenchyma of the fruit stalk of Pisum sativum. The content of Ca and Sr ions in the xylem sap diminished in the direction of the fruit. This finding provided a possible explanation for the low Ca and Sr content in seeds of various plants. (BBB)

41334 CHANGE IN THE POLYPHENOL OXIDASE AND PEROXIDASE ACTIVITY AND THE HILL REACTION IN THE CHLOROPLASTS OF LEAVES AFTER γ IRRADIATION. Kuzin, A. M.; Korolev, N. P. (Inst. of Biological Physics, Moscow). Radiobiologiya, 6: 898-901(1966). (In Russian).

The effects of radiation on the activity of polyphenol oxidase and peroxidase in the chloroplasts of green leaves were compared with the effects of radiation on the photochemical activity of the chloroplasts. Leaves of two to three-week old Vicia faba and lupine plants were subjected to γ irradiation at various doses (from 0.062 to 10.0 kR) at a dose rate of 700 R/min. Irradiation of the leaves at a dose of only 250 R produced a significant increase in the activity of both enzymes in both plants; an increase in the activity of the Hill reaction was observed in the more radiosensitive Vicia faba. At higher radiation doses (1 to 2 kR), the activity of both enzymes decreased to a greater degree in the radioresistant plant, lupine; at 10 kR, the polyphenol oxidase and peroxidase activities in both plants were below the control value, with the exception of the polyphenol oxidase of Vicia faba. Similar phase changes were observed in the Hill reaction. It is proposed that the increase in the activity of the polyphenol oxidase and peroxidase systems in chloroplasts isolated from irradiated leaves is a reaction of the system regulating the plastoquinone redox level, in response to their radiation recovery. The phase nature of the curves both for the Hill reaction and for the enzyme activity is attributed to peculiarities of the system of regulation of the state of plastoquinones and the effects of radiation upon it and peculiarities of the radiation restoration of the plastoquinones. Since radiation induces an increase in the activity of the Hill reaction and the oxidative enzyme at lower doses in Vicia faba than in lupine, the more radiosensitive Vicia faba may contain a more rigorous system of regulation of the state of the plastoquinones, which reacts even to slight changes in their redox level. (JPRS)

41335 RETENTION AND LOSS OF ^{137}Cs BY COMPONENTS OF THE GROUNDCOVER IN A PINE (PINUS VIRGINIANA L.) STAND. Witkamp, Martin; Frank, Marilyn L. (Oak Ridge National Lab., Tenn.). Health Phys., 13: 985-90(Sept. 1967).

Retention, accumulation, and loss of ^{137}Cs by lichen, moss, needle litter, and plant rosettes were measured in a laboratory experiment. Cesium-137 was added to these forest floor components for three months in simulated rain, after which they were leached out with rainwater for five weeks. Accumulation was proportional to ^{137}Cs input. Retention increased in the order plant rosettes (72%) < lichen or needles < moss (96%). Biological uptake, as indicated by differences in retention between live and dead components, accounted for only 4 to 8% of the total retention. Underlying soil reduced retention by needles and lichen about one-third and one-half, respectively. Loss of accumulated ^{137}Cs was more rapid from dead plants than from live ones. Resulting half-times varied between 0.8 and 2.4 years. The calculated ^{137}Cs retention by the entire forest floor was 93%. (UK) (auth)

41336 INCORPORATION OF TRITIATED THYMIDINE INTO MITOCHONDRIAL AND NUCLEAR DNA IN NORMAL AND REGENERATING RAT LIVER BEFORE AND AFTER IRRADIATION. Chang, L. O.; Looney, W. B. (Univ. of Virginia, Charlottesville). Int. J. Radiat. Biol., 12: 187-92(1967).

The incorporation of tritium-labeled thymidine (H-TdR) into mitochondrial DNA (mDNA) and nuclear DNA (nDNA) in the normal and regenerating liver of the rat was investigated. The specific activity in the mDNA of regenerating liver was twice that of normal liver, but the specific activity of nDNA was 48 to 83 times greater in regenerating liver than that in normal liver. A radiation dose of 1500 R local x-irradiation depressed the incorporation of ^{3}H–TdR into the mDNA fraction isolated from both normal and regenerating liver. The magnitude of the immediate depression appeared to be a function of the rate of DNA-synthesis at the time of irradiation. The process of DNA-labelling in the nuclear fraction appeared to be more sensitive to the daily metabolic variation and also to the delayed effect of radiation. A radiation dose of 6000 R at 10.30 a.m. showed a greater immediate reduction in ^{3}H–TdR uptake than 1500 R, in both mDNA and nDNA in the regenerating liver. (auth)

41337 THE ROLE OF LYMPHOCYTES IN ANTIBODY FORMATION. I. RESTORATION OF THE HAEMOLYSIN RESPONSE IN X-IRRADIATED RATS WITH LYMPHOCYTES FROM NORMAL AND IMMUNOLOGICALLY TOLERANT DONORS. McGregor,

D. D.; McCullagh, P. J.; Gowans, J. L. (Oxford Univ.). Proc. Roy. Soc. (London), Ser. B, 168: 229-43(Sept. 12, 1967).

The haemolysin response of rats to an intravenous dose of 10^8 sheep erythrocytes was abolished by pretreatment with 500 rad of whole body X-irradiation. The immunological deficiency in such animals could be corrected equally well by either an injection of thoracic duct cells or by an inoculum consisting almost exclusively of small lymphocytes, obtained in each case from normal (non-immune) rats. The reversal of unresponsiveness depended upon the survival of the donor lymphocytes in the X-irradiated recipients and was not due to a non-specific restoration of the hosts' own capacity to form antibody. Evidence for this conclusion came from experiments in which the X-irradiated recipients were themselves immunologically tolerant of sheep erythrocytes; additional support came from the inability of lymphocytes from immunologically tolerant donors to restore specific responsiveness in X-irradiated (non-tolerant) recipients. In a proportion of trials the immunological tolerance to sheep erythrocytes exhibited by thoracic duct lymphocytes from tolerant donors could be broken by incubating the cells in vitro before their injection into X-irradiated recipients. This points to the existence of individual tolerant cells in the tolerant populations of lymphocytes. Taken as a whole the experiments suggest strongly that small lymphocytes are the precursors of the cells which produce haemolysin against sheep erythrocytes in the rat. (auth) (UK)

41338 PREFERENTIAL DEGRADATION OF GAMMA-IRRADIATED DEOXYRIBONUCLEIC ACID BY CRUDE EXTRACT OF ESCHERICHIA COLI. Trgovcevic, Zeljko; Kucan, Zeljko (Ruder Boskovic Inst., Zagreb). Int. J. Radiat. Biol., 12: 193-4 (1967).

Samples of tritium-labeled DNA were γ-irradiated at a dose rate of 50,000 R/hr and then incubated with excess amounts of a crude extract of Escherichia coli B. Kinetics of the breakdown of the control and irradiated ^{3}H-DNA showed that the rate of breakdown of ^{3}H-DNA irradiated at 50,000 R was consistently higher than that of the control. The increased rate of breakdown was also observed at higher radiation doses. The nature of the enzyme(s) responsible for the degradative process is discussed. (B.H.S.)

41339 AN ENDONUCLEOLYTIC ACTIVITY SPECIFIC FOR ULTRAVIOLET-IRRADIATED DNA IN WILD TYPE AND MUTANT STRAINS OF MICROCOCCUS LYSODEIKTICUS. Shimada, Kazunori; Nakayama, Hiroaki; Okubo, Shunzo; Sekiguchi, Mutsuo; Takagi, Yasuyuki (Kyushu Univ., Fukuoka). Biochem. Biophys. Res. Commun., 27: 539-45(June 9, 1967).

An extract of Micrococcus lysodeikticus that caused release of nucleotides from uv-irradiated DNA, but not from untreated DNA was isolated. Two fractions were separated, one of which contained an endonuclease that caused breaks in uv-irradiated DNA that resulted in changes in the sedimentation patterns (as shown by sucrose gradient centrifugation). This fraction did not appear to require Mg^{++}. The other fraction alone did not produce many breaks, but both fractions acting together plus Mg^{++} were required for extensive nucleotide release. A mutant was found to be defective in the endonucleolytic activity, but to have the same degree of uv-sensitivity as the wild type. (M.M.B.)

41340 THE USE OF RADIOISOTOPES TO INVESTIGATE ORGANIZATION IN PLANTS, WITH SPECIAL REFERENCE TO THE GRASS PLANT. Marshall, C. (University Coll. of North Wales, Bangor, Eng.). pp 203-14 of STI/PUB-137.

From FAO/IAEA Symposium on the Use of Isotopes in Plant Nutrition and Physiology Studies, Vienna, Austria, Sept. 5-9, 1966.

The grass plant is an excellent model for the study of whole plant organization as it consists of tiller units at different stages of development. Little attention has been given to the metabolic interrelationships between the vegetative tillers, and the introduction of radioisotopes as biological tracers allows this to be investigated in a precise manner by the technique of whole plant autoradiography. Although metabolic interrelationships between plant organs have been commonly studied by feeding $^{14}CO_2$ and mineral nutrient isotopes to the plant, very few studies have been carried out on the distribution of both assimilates and nutrients in the same plant system. In the present experiment, on Lolium multiflorum Lam., the pathway of radiocarbon and radiophosphate was followed to enable an assessment to be made on the interrelationships between all parts of the plant. In a plant with two tillers the labelled assimilates produced by each tiller are translocated to adjacent tillers and the root system; labelled phosphate moves from a single root to all tillers and to the other roots. This free movement of metabolites throughout the plant is gradually lost with time, and in a plant with five tillers radiocarbon is not translocated between tillers but moves solely to the root system. Similarly labelled phosphate now moves principally to the tiller to which the treated root is attached and to the other roots. Tillers that were interdependent thus gain independence with time, but because the root system continues to be fully supplied with isotopes by every tiller and every root, the tiller cannot be regarded as an independent unit of the plant. The plant must therefore be considered physiologically as a whole. The removal of all roots but one emphasizes this point in that the tillers, although they are relatively independent can, because they are interconnected, become integrated, receiving a supply of phosphate from a single root. This response is similar to that produced by differential defoliation, and shows that in times of severe physiological stress the plasticity of organization allows the plant to respond positively and overcome its adversity. (auth)

41341 STUDIES ON THE NATURE OF BIOCHEMICAL CONTACT BETWEEN THE RECEPTACLE OF THE STRAWBERRY AND THE REST OF THE PLANT. Antoszewski, R. (Inst. of Pomology, Skierniewice, Poland). pp 217-26 of STI/PUB-137.

From FAO/IAEA Symposium on the Use of Isotopes in Plant Nutrition and Physiology Studies, Vienna, Austria, Sept. 5-9, 1966.

The purpose of this work was to investigate the transport of radioactive phosphate ($Na_2H^{32}PO_4$), sodium chloride (^{24}NaCl), potassium chloride (^{42}KCl), tritiated water (T_2O) and radioactive ^{14}C assimilates from the plant to the receptacle, and from the fruit to the peduncle and other parts of the plant. The investigations were carried out on the Talisman variety of strawberry. The results showed that phosphate preparation injected into the stem was quickly transported to the receptacle of the strawberry. Significant hypotension existing in the xylem is probably the factor responsible for this prompt flow. This hypotension is caused by the fruit itself to a certain degree, because the fruit cut from the plant still shows a significant suction power. The suction power of the receptacle does not directly depend on the transpiration of the receptacle, because this power remains even after a longer period of climatization in the water (5 to 10 hr) and after covering the receptacle with liquid paraffin. There is no polarity of the transport in the peduncle itself as far as phosphate is concerned; this was found by examining the distribution gradient of phosphate in the cut peduncle. In these conditions the pattern of distribution is typical for diffusion processes. Radioactive phosphate given to the fruit was not transported to the other parts of the plant if the vascular bundles were not injured. When the vascular bundles were injured, the phosphate moved along the injured bundles. Similar experiments were carried out with radioactive ^{24}NaCl and ^{42}KCl. Neither ^{24}Na nor ^{42}K flows from the fruit to the plant, using both application on the epidermis of receptacle and injection into the receptacle. There was no influence of injury to the vascular bundles on the export of ^{42}K and ^{24}Na to the peduncle. ^{42}KCl applied on the epidermis of the stem flows rapidly towards the fruit. The peduncle itself does not show polarity of ^{42}K transport. When hypotension was applied to the cut stem using a water pump, the movement of water in the xylem could be produced. In this case the potassium applied on the epidermis of the stem moves towards the source of hypotension. It can be stated, therefore, that potassium in vivo is transported from the stem to the receptacle in the water stream activated by the suction power of the receptacle. The tritiated water applied on the epidermis of the receptacle penetrates into the receptacle, but is not transported to the peduncle. Assimilation of $^{14}CO_2$ receptacle tissues and transport of radioactive assimilates to the peduncle were investigated by placing the fruit in a securely sealed chamber containing radioactive $^{14}CO_2$. The results of these experiments show that some assimilates are exported from the receptacle to the peduncle. These assimilates were separated by means of paper chromatography. The chemical composition of those exported assimilates is different from that of the assimilates left in the receptacle. (auth)

41342 ON THE USE OF ^{14}C AND ^{32}P IN LOCATING GENETICALLY CAUSED DEFECTS IN PHOTOSYNTHESIS OF SOME PLASTID MUTANTS. Hallier, U. V. (Univ., Bonn). pp 235-45 of STI/PUB-137.

From FAO/IAEA Symposium on the Use of Isotopes in Plant Nutrition and Physiology Studies, Vienna, Austria, Sept. 5-9, 1966.

It is well known that all reactions of cellular metabolic physiology are regulated by the regulatory effects of genes. This dependence of biochemical reactions on genes can be investigated under favorable circumstances with the help of certain suitable mutants. The place of activity of certain genes can be localized by biochemical methods as well as by using radioisotopes. The extensive complex of reactions of which photosynthesis is composed was checked on some plastid mu-

tants of Oenothera suaveolens. These plants are lethal mutants that, from their development and appearance, are assumed to starve because of insufficient photosynthetic activity. In searching for such a possible genetically caused block in the mechanism of photosynthesis, the respiratory and photosynthetic effect was checked and the intensity of assimilation was tested by the use of $^{14}CO_2$. The carbon cycle was divided into partial processes checked in vitro one by one; then the light-dependent reactions of photosynthesis, leading to formation of ATP and NADPH, were investigated as well as, by means of ^{32}P, the ability of photophosphorylation. As the results point out, the defect of the mutants leading to lethality must be assumed within the chain of electron transport. (auth)

41343 UPTAKE AND UTILIZATION OF PHOSPHORUS BY MAIZE FROM FOLIAR SPRAYS. Datta, N. P.; Vyas, K. K. (Indian Agricultural Research Inst., New Delhi). pp 371-6 of STI/PUB-137.

From FAO/IAEA Symposium on the Use of Isotopes in Plant Nutrition and Physiology Studies, Vienna, Austria, Sept. 5-9, 1966.

A clear distinction between root and non-root absorbed nutrients occurring simultaneously in the plants can be made by the use of isotopes. An evaluation has been carried out of the magnitude of the nutritional contribution of a number of foliar-applied phosphates labelled with ^{32}P. The fertilizers used were superphosphate, monocalcium phosphate, dicalcium phosphate, and ammonium phosphate labelled at 0.12 mCi/g P_2O_5. Spray dose was equivalent to a 5 lb P_2O_5/acre application; volume was just enough to wet the foliage without causing run off. pH of the solutions were: superphosphate 4.0, monocalcium phosphate 4.0, dicalcium phosphate 5.5, and ammonium phosphate 4.0. Spraying was done at three stages of growth (24, 39, and 60 d after germination). Using ^{32}P-tagged material, assessments were made of the effect of washing foliage before analysis for loss of phosphorus from leaves, and of materials sticking to foliage. There was no loss of phosphorus from leaves from washing to remove unabsorbed materials sticking to leaves from spray. Percentage uptake of fertilizer phosphorus from spray was greater at the early stages of growth compared with later stages. At the early stage of growth with comparable doses, spray application has been eight times as efficient as soil application. For spraying ammonium phosphate is the most efficient fertilizer. This shows the beneficial effect of spray fertilization. The data on maize proved that where higher doses of fertilizer through soil application cannot be economically utilized, only 5 lb/acre dose of spray application at early stages of growth can be more efficiently utilized by the plants. Thus economy in the use of phosphatic fertilizers can be made by spraying. (auth)

41344 ROOT UPTAKE AND LOCALIZATION OF ^{45}Ca IN YOUNG TREES (POPLARS AND THUYAS) DURING A COMPLETE GROWTH CYCLE. Gagnaire, Janine (Commissariat a l'Energie Atomique, Grenoble, France). pp 377-89 of STI/PUB-137. (In French).

From FAO/IAEA Symposium on the Use of Isotopes in Plant Nutrition and Physiology Studies, Vienna, Austria, Sept. 5-9, 1966.

In the course of several complete growth cycles, from March 1963 to December 1965, and after contamination of the culture medium with radioactive calcium for a limited time varying from two to ten weeks, the authors compared the root uptake and localization of radioactive calcium in several kinds of caducous and persistent leaves cultivated either in earth sieved in Riviera pots, under the climatic conditions of Grenoble, or hydroponically in the laboratory. Activity measurements were made by β-spectrometry, using a Tricarb spectrometer and statistical checking of the scatter. The authors studied the differences in the capacity of the various tissues of each type to concentrate radioactive calcium during a complete growth cycle. The findings shed light on the various phases of the growth cycle of each type. (auth)

41345 AUTOHISTORADIOGRAPHIC INVESTIGATION OF ROOT EXUDATION IN THE SOIL AFTER FOLIAR UPTAKE OF ^{32}P. Khau Van Kien, L. (Commissariat a l'Energie Atomique, Cadarache, France). pp 391-400 of STI/PUB-137. (In French).

From FAO/IAEA Symposium on the Use of Isotopes in Plant Nutrition and Physiology Studies, Vienna, Austria, Sept. 5-9, 1966.

Considerable progress has been made recently in the investigation of root exudates, as a result of the use of radioisotopes and sterile cultures. So far, however, no use has been made of autohistoradiographic techniques in making an accurate description of the phenomena in situ, because it is difficult to make on the spot histological sections of roots in a soil containing hard particles and at the same time prevent mobilization and diffusion of the exudates. An original technique using plant material cultivated under good conditions in media such as clay, kaolin or gelose, prepared so as to be similar to natural soil and advantageous for the preparation of sections for microscopy is described. Prior freezing of the medium and the use of a cryotome at -17°C led to good cytological results. The colored autoradiographed sections showed very fine localizations in the root system and surrounding medium. These first over-all localization findings could be used for a histochemical description of the exudates, and for studying the physiological responses of the host plant to the soil and microflora of the rhizosphere. The technique should throw light on the mechanism by which various substances are exuded through the epidermal cells of the root. (auth)

41346 AMOUNT OF SULPHUR DIOXIDE ABSORBED BY PLANTS FROM THE ATMOSPHERE. Furrer, O. J. (Federal Research Station of Agricultural Chemistry, Bern). pp 403-7 of STI/PUB-137.

From FAO/IAEA Symposium on the Use of Isotopes in Plant Nutrition and Physiology Studies, Vienna, Austria, Sept. 5-9, 1966.

To measure the uptake of atmospheric sulphur the plants were cultivated in nutrient solutions containing radioactive sulphate (^{35}S). The nutrient solutions were bubbled by sulphur-free air and hermetically separated from the surrounding atmosphere containing inactive sulphur dioxide. The experiments were carried out with different species of plants, with varying amount of sulphate in the nutrient solution and with varying amounts of sulphur dioxide in the atmosphere. The amount of sulphur and the specific activity of ^{35}S were determined in the organic and inorganic fraction of the different parts of the plants. The absorption of atmospheric sulphur by plants was greater with higher concentrations of sulphur dioxide in the air. On the other hand, the uptake of atmospheric sulphur by plants was lower with higher sulphur concentrations in the nutrient solution. Sulphur from the atmosphere was found in greater concentration in the inorganic than in the organic sulphur fraction of the plants. Sulphur from the atmosphere was also found in the roots but in lower concentration than in the tops of the plants. The radioautographs showed a higher concentration of sulphur in the younger tissues. (auth)

41347 GENETIC VARIANTS AS FACTORS AFFECTING THE NUTRITION AND PHYSIOLOGY OF PLANTS. Brown, J. C. (Dept. of Agriculture, Beltsville, Md.). pp 413-19 of STI/PUB-137.

From FAO/IAEA Symposium on the Use of Isotopes in Plant Nutrition and Physiology Studies, Vienna, Austria, Sept. 5-9, 1966.

Of 14 plant species or varieties grown on a calcareous, zinc deficient soil, seven developed zinc deficiency, two developed iron deficiency and five had no deficiency symptoms. Of 19 plant species or varieties grown on a calcareous, iron deficient soil and on an organic, copper deficient soil, six plants developed iron deficiency, but did not develop copper deficiency, five plants developed copper deficiency, but did not develop iron deficiency, four plants showed retarded growth and slight iron and copper deficiency symptoms and four plants developed neither iron nor copper deficiency. These observations show that genetic variants in plants can exert an influence on the absorption and utilization of a nutrient element. Phosphate has been found to accentuate iron, copper, and zinc deficiency symptoms, and those genotypes inefficient in the utilization of a specific element appear to utilize phosphate differently than an efficient genotype. Copper deficiency symptoms in barley, corn, and wheat appear related to the status of calcium in the plant. New leaves exhibiting symptoms of copper deficiency contain less calcium and iron and more phosphorus than comparable copper sufficient leaves. There is the implication that the availability of iron involves two steps: sorption of iron by the root, and translocation of iron to the top of the plant. The translocation of iron in stem exudate is accompanied by citrate. Iron translocated in stem exudate and separated by electrophoresis moves towards the anode. Radioautograms and electrophoretically separated components of the stem exudate showed that ^{54}Mn and ^{65}Zn did not substitute for ^{59}Fe in the stem exudate, although they did inhibit the translocation of ^{59}Fe. Iron efficient genotypes had a greater reducing capacity at the root and a greater capacity to utilize iron from iron chelate than iron inefficient genotypes. The amount of Fe at the root was less important than the form of Fe (Fe^{3+} or Fe^{2+}). There is evidence that Fe^{2+} is more available to plants than Fe^{3+}. Maximum reduction and uptake of iron at the root occurs in an iron efficient genotype that is under an iron stress, and the reactions involved are accompanied by the release of hydrogen ions into the growth medium. (auth)

41348 THREE STAGE ELECTRON TRANSFER IN AQUEOUS AND ALCOHOLIC SOLUTIONS. Adams, G. E. (Mount Vernon Hospital, Northwood, Eng.); Michael, B. D.; Richards, J. T. Nature (London), 215: 1248-50(Sept. 16, 1967).

Molecules of high electron affinity may be able to enhance radiobiological damage by increasing the effective diffusion radius of hydrated electrons produced by radiation. They do this by acting as electron carriers and electron transfer agents. (auth) (UK)

41349 ANTIOXIDANTS AND LIPOPEROXIDES IN THE ORGANS OF IRRADIATED RATS. III. IMPORTANCE OF THE DOSE-RATE. Glavind, Johs (Polytechnic Inst., Copenhagen); Faber, Mogens. Int. J. Radiat. Biol., 12: 121-6(1967).

Rats were irradiated with 100,000 R at high and low dose rates. The smallest decline in water-soluble antioxidants in brain and liver was observed at low dose rate where repair is possible during the irradiation. On the other hand, lipoperoxides were formed in adipose tissue in larger amounts at the low dose rate. A great amount of lipoperoxides was found as normal constituents of both skin and hair. The results are discussed and compared with previous reports on apparent peroxide in irradiated mice. (auth)

41350 THE RETENTION OF ^{90}Sr TRANSFERRED THROUGH MILK (AND PLACENTA) IN RAT OFFSPRING. Hopkins, B. J. (Univ. of Rochester, N. Y.). Health Phys., 13: 973-6(Sept. 1967).

The retention in suckling young of ^{90}Sr accumulated during late foetal life and during the period of nursing following a single maternal injection was measured in rats. Rat dams of the Long-Evans strain were injected intravenously with 379 μCi of ^{90}Sr on day 17 post-conception. Bremsstrahlung measurements based upon 65 offspring showed that a body burden of 1.49 μCi per offspring was contained at birth. At least 1.19 μCi in excess of the body burden at parturition was accumulated from the milk by day 14 post birth. Fractional retention of ^{90}Sr in the offspring between 40 and 300 days post-weaning was described by the equation $R = 0.006\ t^{-0.13}$. (auth) (UK)

41351 SEASONAL VARIATION OF ^{137}Cs FROM FALL-OUT IN A CLAM, RANGIA CUNEATA GRAY. Wolfe, D. A. (Bureau of Commercial Fisheries, Beaufort, N. C.). Nature (London), 215: 1270-1(Sept. 16, 1967).

In northern temperate zones fall-out of long-lived radionuclides, including ^{137}Cs, varies seasonally, with a maximum during May–June and a minimum during November–December. Chemically caesium resembles potassium, which is the principal cation of cytoplasm, and the bio-accumulation of caesium has therefore aroused considerable interest. Whereas the concentration of caesium in marine organisms is usually 3 to 30 times higher than in the surrounding water, in fresh water it may be higher by a factor of 100 to 1000. It has been shown that for certain organisms the biological concentrations of caesium and potassium are directly related to one another and their concentration factors inversely related to the salinity of the water. In the study described the bivalve mollusc Rangia cuneata Gray was collected from a number of stations in an estuary in N. Carolina, and the amounts of ^{137}Cs and ^{40}K in the soft tissues were measured periodically for 18 months. The salinity of the water varied seasonally and showed an inverse relation to the $^{137}Cs/^{40}K$ ratio in the mollusc. The concentration of ^{40}K in the tissues increased only two-fold with salinity. Since the potassium concentrations were essentially constant, variation in the $^{137}Cs/^{40}K$ ratio chiefly represented changes in ^{137}Cs concentration. Reasons for the observed seasonal fluctuations of ^{137}Cs content are advanced. (UK)

41352 PLASTIC ENCLOSURES FOR IN VIVO RADIOASSAY OF INSECTS. Lippold, P. C. (New York State Agricultural Experiment Station, Geneva). Int. J. Appl. Radiat. Isotop., 18: 656-8(Sept. 1967).

In order to assay living insects the active species must be confined in such a way as to obtain suitable counting geometry. A variety of insect stages was used in radiotracer ovicide-insect studies at Geneva. In some instances stages mounted on double stick cellophane tape in planchets escaped and contaminated counting equipment. An inexpensive plastic molding device for planchet covers provided a solution to this problem. Its manner of use is described, together with examples of radioassays. The experiments demonstrated that this type of enclosure can be successfully employed for insects labeled with ^{32}P or more energetic radionuclides. The covers could also be used to confine insects on plants, and are convenient for covering ashed samples, precipitates, and standards. (UK)

41353 SIMULATION OF THE RADIOHIPPURAN RENOGRAM TEST ON AN ANALOGUE COMPUTER. Knudsen, E. (Finsen Lab., Copenhagen); Hoejberg, K. Soee. Int. J. Appl. Radiat. Isotop., 18: 639-46(Sept. 1967).

A mathematical model for the simulation is described. The model incorporates one part for the simulation of the kidney dynamics and another part for the simulation of the hippuran transport in the human body from the place of tracer injection to the kidney. (auth)

41354 EFFECT OF HIGH DOSE RATES ON SURVIVAL OF MAMMALIAN CELLS. Town, C. D. (St. Bartholomew's Hospital, London). Nature (London), 215: 847-8(Aug. 19, 1967).

Studies are described with a view to determining the differences in cell survival when exposed to radiation delivered in a single pulse or in two pulses. The biological system employed was a sub-clone of HeLa S-3 cells, irradiated in suspension at 25°C twenty-four hours after collection. The radiation source was a 15 MeV linear accelerator, producing electron beam pulses of 1.3 μsec, and the maximum dose used was 4,500 R in one pulse, corresponding to a mean dose rate of 3.5×10^9 R/sec. Lithium fluoride thermoluminescence dosimetry was employed, checked by ferrous sulphate and red Perspex dosimetry. In the first series of experiments the cell suspensions were corked in polystyrene bottles after routine handling in air. It was found that the single pulse data followed the two-pulse (separation time 2.5 m sec) line very closely up to about 900 R, but for larger doses the single pulse irradiated cells showed greatly reduced sensitivity. The biphasic nature of the single pulse curve was thought to be caused by oxygen removal within the cell by reaction with radical intermediates. Change from oxic to anoxic sensitivity occurred over a relatively small dose range. In order to confirm this hypothesis a second series of experiments was carried out in which an inert antifoam agent was added to the cell suspension, and either air or nitrogen bubbled through before and during irradiation. It is suggested that in the vicinity of the sensitive sites within the cell either the equilibrium oxygen concentrations are much lower, or the G-value for oxygen removal is much higher, than the values in the extracellular medium (UK)

41355 MEASUREMENT OF THE RETENTION AND EXCRETION OF INCORPORATED ^{65}Zn. Andrasi, Andor; Feher, Istvan (Central Research Inst. for Physics, Budapest). Health Phys., 13: 915-16(Aug. 1967).

Zinc-65 retention in the body of man was measured by whole-body counting. The effective half-life, as determined by computer evaluation (method of weighted least squares), was 141.4 ± 0.7 days. The excretion of ^{65}Zn was followed by measurement of the activity in daily feces and urine samples. The average total fractional elimination rate was 0.3% per day and the feces to urine excretion ratio was greater than 3. It was concluded that the major fraction of ^{65}Zn was excreted through the intestinal tract. (B.H.S.)

41356 UPTAKE OF FERTILIZER PHOSPHORUS BY RICE AS DETERMINED BY RADIOACTIVE PHOSPHORUS ^{32}P. Murty, K. S.; Rao, Ch. Narasinga (Central Rice Research Inst., Cuttack, India). Sci. Cult. (Calcutta), 33: 239(May 1967).

The type of placement of fertilizer P necessary for maximum uptake of P by rice plants was investigated using ^{32}P. Phosphorus (52 ppM) was added to the soil in the form of ^{32}P-labeled NaH_2PO_4 by subsurface placement (5 in. depth), surface placement, and thorough mixing with the top 5 in. of soil. Phosphorus uptake and utilization by rice plants in the early stages of growth and up to 6 weeks after planting was greater when the P was added to the soil at the surface level. The P absorbed during this period was most efficiently utilized for grain production and was adequate for an optimum crop yield. It was concluded that fertilizer P should be added to the soil by surface placement. (B.H.S.)

41357 ^{3}H-THYMIDINE INCORPORATION INTO NUCLEAR DNA OF LEAF CELLS. Maksymowych, R.; Devlin, R. G.; Blum, M. K.; Wochok, Z. S. (Villanova Univ., Pa). Plant Physiol., 42: 814-18(June 1967).

The incorporation of ^{3}H-thymidine into nuclear DNA of leaf cells of Xanthium pennsylvanicum was studied as a function of concentration and specific activity of the radioisotope. From the assessment of the average number of grains per nucleus and the percent of labeled nuclei, it was concluded that the incorporation was a linear function of concentration of the exogenous radioisotopic solution and a logarithmic function of the incubation time. Ten μCi/ml on the average yielded 20% of labeled nuclei with 18 grains per nucleus. Seven-fold increase in concentration only doubled the amount of ^{3}H-thymidine incorporated. The lamina regions near the vein incorporated a significantly greater amount of the radioisotope than the lamina region at some distance from the vein. The specific activities of 2, 3.35, 6.7, and 15.3 Ci/mmole had no effect upon the amount of ^{3}H-thymidine incorporated, if the amount of microcuries of the incubation solution was the same in each activity. Considering the total number of molecules, the estimated rates of incorporation indicated that at the activity of two Ci/mmole, the system operated with about seven times higher rates as compared with the activity of 15.3 Ci/mmole. (auth)

41358 PASSAGE OF ^{198}Au THROUGH THE SMALL INTESTINE. Andrysek, O.; Setka, J.; Georgi, P.; Gutz, H. J.; Altenbrunn, H. J.; Berndt, H. (Biophysical Inst., Prague). Cas. Lek. Cesk., 106: 210-13(Feb. 1967). (In Czech).

Gold-198 was not absorbed in the intestinal tract; it was inert. When only 0.1 mg was used, it did not irritate the intestinal wall during examination; the passage of ^{198}Au was checked by repeated scintigraphy. When administered per os to fasting animals, it took the ^{198}Au two hours to reach Bauhin's valve; Ba meal influenced the transit time. (auth) (CFSTI)

41359 EFFECT OF SOIL TEXTURE ON THE ACCUMULATION OF ^{137}Cs IN WHEAT YIELD. Yudintseva, E. V.; Gulyakin, I. V.; Alpatova, A. N. (Biophysics Lab., Moscow). Agrokhimiya, No. 6, 82-9(June 1967). (In Russian).

The ^{137}Cs uptake by plants and its accumulation in wheat crops was in direct dependence on the size of the soil particles. The smaller the soil particles, the greater the concentration of the nuclide in the crop. The stability of the fixation of the absorbed radiocesium was increased with decreased diameter of the soil particles. Oozy soil fractions very firmly fixed ^{137}Cs and therefore its uptake in the plants and accumulation in the crops was reduced more sharply than fractions of clay and sand. In its effect with respect to the decrease of the uptake of radiocesium in plants, oozy fractions were equal to, and in a series of cases, decreased the concentration of ^{137}Cs in the wheat crop to a greater degree than soils from which the ooze was removed. (tr-auth)

41360 INVESTIGATIONS ON THE INFLUENCE OF CALCIUM AND POTASSIUM ON ^{90}Sr UPTAKE BY RED CLOVER AND PASTURE GRASS. Reissig, Herbert; Fiedler, Hans-Joachim (Technische Univ., Dresden). Albrecht-Thaer-Arch., 10: 971-89 (1966). (In German).

The influence of $CaCO_3$ and KCl + $CaCO_3$ on the ^{90}Sr adsorption of red clover and rye greas was studied in pot experiments with dust loam poor in calcium, between 1962 and 1964. $CaCO_3$ reduced the ^{90}Sr : Ca ratio in the plants up to a quantity which would be sufficient for a 100 percent Ca-saturation of the cation exchange capacity of the soil. The greatest possible reduction of the ^{90}Sr : Ca ratio in the plants may be estimated with sufficient accuracy for practical purposes by the following formula: $S(\%)_{max} = [1 - (Ca_{exchangeable}$ (mval/100 g soil)/cation exchange capacity (mval/100 g soil))] · 100. The correlations between the ^{90}Sr : Ca ratio of the test plants (y) and the exchangeable soil-Ca (x) may be fairly described by the $y = kx^e$ potential function, where k and e are proportionality constants. The empirical values obtained from the pot experiments for the average correlations between soil and plant contamination [(pCi^{90}Sr/g Ca (plant)/mCi^{90}Sr/sq.km. (soil))] are in good agreement with the values obtained from field experiments. KCl fertilization had small or no effect on the ^{90}Sr : Ca ratio of the test plants. The ^{90}Sr content in the dry matter was positively or negatively affected by KCl-fertilization, with the actual effects depending on both plant species and the potassium : calcium ratio in the fertilizer. (auth)

41361 CELL CLONING EXPERIMENTS AS MODELS FOR RADIOTHERAPY: A CRITICAL APPRAISAL. Mendelsohn, Mortimer L. (Univ. of Pennsylvania, Philadelphia). Nat. Cancer Inst. Monogr., No. 24, 157-67(Feb. 1967).

Several models of cell survival derived from radiobiological experiments are examined in relation to their applicability to tumor radiotherapy. Cell survival curves can be divided into shoulders and straight-line portions. The slope of the logarithm of surviving fraction vs radiation dose, as taken from the straight part of the curve, is commonly related to the sensitivity of the cells in question. With radiations of high LET, the shoulder region of the survival curve becomes less significant and may disappear altogether. Variations in sensitivity up to a factor of ~2 occur in specific phases of the cell cycle. Major differences in mitotic timing are known to exist among various cells and tissues, and these might be used in combination with temporal sensitivity in the design of optimum fractionation schedules. Hypothetical diagrams illustrated how the method could be applied. Ideally the second dose of radiations should be given when the surviving tumor cells have advanced into a sensitive region and when the surviving normal cells are in a resistant phase. Although the principle of this method is straightforward, the actual application is complex. Apart from the difficulties that arise in trying to apply cell-cloning survival curve models to radiotherapy, there are also questions about the overall suitability of the models for the problem at hand. For example, such models may not provide for the so called stromal factors in radiotherapy. It is suggested that the extension to clinical therapy of models based on clonal cell survival is presently an interesting academic exercise but is not to be taken seriously. Furthermore with so many ill defined variables it is not even reasonable to expect answers in the near future. Thus it is urged that the therapist should continue studying his own material, looking for better methods, and the radiation biologist should not abandon the more immediate experimental models of radiotherapy. (BBB)

41362 PHOTOREACTIVATION OF UV-IRRADIATED BLUE-GREEN ALGAL VIRUS LPP-1. Wu, J. H. (California State Polytechnic Coll., Pomona); Lewin, Ralph A.; Werbin, Harold. Contract AT(11-1)-34. Virology, 31: 657-64(Apr. 1967).

Attempts were made to determine whether it is possible to photoreverse uv damage to LPP-1 virus, and, if so, to establish which spectral regions are active for this process. Such information would reveal a possible dependence of photoreactivation on photosynthesis. The uv-induced damage to this DNA virus that infects the blue-green alga Plectonema boryanum could be partially reversed by illuminating the alga subsequent to infection. Photoreactivation was induced by white or blue light but not by red or so-called black light (maximum intensity at 356 mμ). Since red light supported photosynthesis, there is apparently no interdependence between photosynthesis and photoreactivation. The uv-irradiated alga was photoreactivated by black light as well as by white or blue light. The finding that black light restores algal but not viral replication suggested that the mechanisms respectively involved in the photorepair of viral and algal nucleic acids are dissimilar. (BBB)

41363 SOME STUDIES ON γ-IRRADIATED DNA AS PRIMER IN RNA SYNTHESIS. Weiss, J. J.; Wheeler, C. M. (Univ. of Newcastle upon Tyne, Eng.). Biochem. Biophys. Acta, 145: 68-75 (Aug. 22, 1967).

The enzymatic RNA synthesis primed by γ-irradiated DNA from different sources (calf thymus, bacteria) was studied. There is an appreciable decrease in the rate of the RNA synthesis with increasing dose of radiation; when the reciprocal of the relative priming activity of the irradiated DNA is plotted against dose, straight line graphs are obtained. This is in accord with the proposed model, viz: that γ radiation creates new binding sites for the polymerase, which sites, however, are not effective in the enzymatic synthesis. Of the known effects of radiation on DNA, the breaking of the back bone is apparently by far the most effective in decreasing the RNA synthesis; attack on the bases leads to relatively smaller changes, but does bring about some alteration in the base ratios and in the nearest-neighbor distribution of the newly synthesized RNA. (auth)

41364 INCORPORATION OF ^{32}P INTO MITOCHONDRIAL AND NUCLEAR DNA IN REGENERATING LIVER. Nass, S. (Eastern Pennsylvania Psychiatric Inst., Philadelphia). Biochim. Biophys. Acta, 145: 60-7(Aug. 22, 1967).

^{32}P incorporation into the liver DNA of normal and hepatectomized rats was studied. Four hours after injection of ^{32}P into normal rats the mitochondrial DNA had a specific activity six times as great as did nuclear DNA. Twelve hours after hepatectomy a four hour incorporation of ^{32}P showed that the specific activity of mitochondrial DNA was 18 times as great as that of nuclear DNA and accounted for 50% of the ^{32}P incorporated into the total liver DNA. At 24 hour post hepatectomy the rate of nuclear synthesis of DNA reached a maximum and the specific activities of nuclear and mitochondrial DNA were then equal after a four hour incorporation. When normal rats were injected with ^{32}P and sacrificed at times between one and 14 days after injection it was found that the specific activity of the mitochondrial DNA did not change appreciably during that period. In hepatectomized animals, both nuclear and mitochondrial DNA reached a maximum specific activity two days after injection and then both decayed at the same rate. The results indicate that mitochondrial DNA, like nuclear DNA, is metabolically stable and that DNA synthesis in normal rat-liver mitochondrial and nuclear DNA were slightly but consistently different. A metabolically active contaminant associated with purified mitochondrial DNA after enzymatic digestion to mononucleotides was identified as AMP. (auth)

41365 ADDITION RADICALS AND RADICAL REACTIONS IN DNA IN THE SOLID PHASE. Van de Vorst, Albert (Univ., Liege. Institut d'Astrophysique, Cointe-Sclessin, Belg.). Int. J. Radiat. Biol., 12: 153-61(1967). (In French).

A quantitative study of the x- and γ-ray-induced free radicals in DNA showed that the only observed H-addition radicals were those localized in thymine. The evolution, as a function of temperature, of the form and intensity of the spectrum indicated, on the other hand, the existence of secondary radical reactions that ultimately led to thymine. (auth)

41366 INHIBITION OF LIPOLYTIC ACTION OF GROWTH HORMONE AND GLUCOCORTICOID BY ULTRAVIOLET AND X RADIATION. Fain, John N. (Brown Univ., Providence). Science, 157: 1062-4(Sept. 1, 1967).

Addition of catecholamines or growth hormone plus glucocorticoid activates lipolysis in isolated white-fat cells of the rat. If the fat cells were irradiated just before the addition of growth hormone and glucocorticoid, their lipolytic action was abolished. However, irradiation did not affect the activation of lipolysis by catecholamines. (auth)

41367 DESOXYRIBONUCLEIC ACID (DNA) SYNTHESIS IN THE RADIATED AND STIMULATED THYROID GLAND. Dobyns, Brown M.; Rudd, Ann E.; Sanders, Mary Ann (Cleveland Metropolitan General Hospital). Endocrinology, 81: 1-13(July 1967).

Nuclear changes and DNA synthesis of thyroid cells of rats in early and late post ^{131}I radiation were explored. Tritiated thymidine and radioautography were used to identify nuclei which were synthesizing DNA, and Feulgen staining and microspectrophotometry were used to measure amounts of DNA in individual nuclei. Thiouracil was used as a stimulus. Although obvious destruction of cells with rapid loss of function was not observed, subtle damage was demonstrable by newer methods. Thyroids that retained 1.5 to 2 μCi of a dose of ^{131}I (2640 rads), when stimulated early after radiation, displayed some transient impairment in capacity for DNA synthesis, followed by a supramaximal response at 2 months. A stimulus at 8 months produced DNA synthesis and increased thyroidal weight comparable to nonirradiated glands, but unusual variations in nuclear DNA and volume persisted. Large and sometimes bizarre nuclear forms were usually synthesizing DNA. In contrast, thyroids that retained 15 to 20 μCi (26,400 rads), without obvious thyroidal destruction, lost the ability to synthesize DNA and to hypertrophy when stimulated. Later, the ability to synthesize DNA and to increase in weight remained impaired. Marked variation in individual DNA content among cells persisted. Some nuclei contained amounts of DNA greater than two times the diploid value at which cell division should have taken place. The observations presumably explain the common ultimate functional failure of human thyroids years after a seemingly ideal therapeutic dose of ^{131}I. The ultimate loss of thyroidal function results from failure of replication based on failure of DNA synthesis that occurs after larger doses of ^{131}I, or thwarted cell division that occurs after somewhat smaller doses. (auth)

41368 DYNAMIC PARAMETERS OF MYOCARDIAL CONTRACTILITY UNDER INFLUENCE OF CALCIUM AND STRONTIUM. de Hemptinne, A.; Weyne, J.; Leusen, I. (State Univ., Ghent). Arch. Int. Physiol. Biochim., 75: 96-108(1967).

The influence of different concentrations of Ca and Sr on several parameters of the isometric contraction of cat papillary muscles and atrial preparations was studied. It was shown that increasing Sr concentrations have an effect comparable to that of increasing Ca concentrations. A dissociation of the inotropic effect of cooling was observed in a medium containing a high Ca concentration and one containing a high Sr concentration. On progressive transition from a Sr-containing medium to a Ca-containing medium an initial negative inotropic response was observed, followed by a secondary increase of contractility. This phenomenon is discussed in relation with the changes that are observed in developed twitch tension, rate of tension development, time to peak tension, and total contraction duration in these conditions. A close relation was observed between duration and time course of the action potential and the contraction phenomenon. (BBB)

41369 A MICROAUTORADIOGRAPHIC STUDY OF ^{45}Ca AND ^{35}S DISTRIBUTION IN THE INTACT BEAN ROOT. Biddulph, Susann F. (Washington State Univ., Pullman). Planta, 74: 350-67(Apr. 1967).

Microautoradiographic techniques were used to determine the distribution of ^{45}Ca and ^{35}S in regions of the bean (Phaseolus vulgaris) root where anatomical features may influence the processes of ion uptake and translocation. The ^{45}Ca distribution was determined after 75 min of uptake, after two efflux periods, and after replacement by nontracer Ca. ^{35}S distribution was determined after 75 min of uptake. The quantity of ^{45}Ca that entered the root was greater than the quantity of ^{35}S. The ^{45}Ca concentration within the root increased with linear distance from the eight mm level behind the tip. The pathways of ^{45}Ca and ^{35}S across the cortex appeared to be different since ^{45}Ca was particularly associated with cell walls and ^{35}S was distributed more evenly through the cells. There was no evidence that the endodermis was a diffusion barrier for ^{45}Ca; the small parenchyma cells associated with conducting elements acquired a high concentration of ^{45}Ca and thus appeared to be implicated in absorption and perhaps in transfer to the xylem. (BBB)

41370 SPIN-TRANSFER IN MOLECULAR COMPLEXES OF BIOMOLECULES WITH RADIOSENSITIZERS. Nicolau, Claude; Korner, Octavian; Cristea, Alexandru (Centre for Radiobiology and Molecular Biology, Bucharest). Rev. Roum. Phys., 12: 95-9 (1967).

Electron paramagnetic resonance (EPR) measurements carried out on γ-irradiated molecular complexes of calf thymus DNA, yeast RNA, cytosine, and guanine with radiosensitizers (riboflavin or menadione) showed that even in vitro, a measurable dose-increasing factor occurred. Determinations of G_R for the irradiated complexes and irradiated biomolecules yielded data consistent with predictions based upon consideration of impurity levels introduced in large biomolecules by the sensitizers or of perturbation by these substances of the resonance energy per π electron in the naturally occurring pyrimidines and purines. A charge-transfer complex that was characterized by large concentrations of unpaired spins was detected in unirradiated complexes of DNA and cytosine-quanine bases with the radiosensitizers. (auth)

41371 CHANGES IN OXIDATIVE CLEAVAGE OF DNA IN THE BRAIN AND SPLEEN OF X-IRRADIATED RABBITS. Kakuliya, M. E. Soobshch. Akad. Nauk Gruz. SSR, 46: 625-30 (June 1967). (In Russian).

Investigation of the oxidative degradation of DNA by acid deoxyribonuclease (DNAase) in the brain and spleen of x-irradiated animals revealed that there was no deviation from that in nonirradiated animals. However, during the initial period of hydrolysis by acid DNAase, the DNA spallation in the spleen was faster in the irradiated animals. The effect was the result of the irradiation and the rupture of the phosphorus bonds of the DNA induced by oxidative degradation. Oxidative cleavage of DNA in vitro was enhanced at a 12 R radiation dose. Denaturation did not influence the splitting effect produced by the DNAase. The activity of acid DNAase was lower in the brain of old animals than in the brain of young animals. (R.V.J.)

41372 REACTIONS OF PHOTOCYCLOADDITION TO DNA AND THEIR BIOLOGICAL INTEREST. Musajo, L. (Univ., Padua). Chim. Ind. (Milan), 49: 131-5(Feb. 1967). (In Italian).

The effects of uv irradiation on DNA in the presence of various photoactive compounds are reviewed. On the basis of different tests, photodynamic substances (which include compounds of far different composition) are classified into 3 groups: dyestuffs, acting by photooxidation, whose action is oxygen-dependent; furocoumarins, without photooxidative action, whose action on biologic systems (like the sunburn of human skin, followed by pigmentation) is oxygen-dependent, and; benzopyrene and other polycyclic aromatic hydrocarbons, having properties similar to those of group one and two compounds. Studies are described that have recently revealed the mechanism of action of these substances. Their activity is manifested by their capacity to react with DNA during uv irradiation at 3655 Å. Points of attack on the DNA molecule are the pyrimidine bases, to which the furocoumarins are bound by cycloaddition with formation of a cyclobutane ring. Experiments are described in which Ehrlich ascites tumor cells were inactivated by uv irradiation (3655 Å) in the presence of various furocoumarins. (BBB)

41373 STUDIES ON THE EFFECT OF INTERFERON ON THE FORMATION OF ANTIBODY IN MOUSE SPLEEN CELLS. II. THE EFFECT OF INTERFERON ON ANTIBODY PLAQUE FORMATION AND ANTIBODY PRODUCTION BY TRANSFERRED SPLEEN CELLS. Mazzur, Scott R. (New Jersey Dept. of Health, Trenton); Paucker, Kurt. J. Immunol., 98: 689-96(Apr. 1967).

The transfer of interferon-treated spleen cells in x-irradiated mice was used to study the effect of interferon on antibody formation. Since agglutinating antibodies can be measured when spleen cell suspensions are transferred to irradiated recipients, this method was employed to show how in vitro exposure of primed spleen cells to interferon affects the development of agglutinating antibodies. Furthermore, transfer of spleen cells to irradiated mice permitted study of the effect of interferon on secondary antibody synthesis. In no case did interferon exert any effect on the synthesis of antibody. However, antibody production could be depressed by exposure to the PR8 strain of influenza A virus. Since this effect of PR8 could be prevented by pretreatment of the cells with interferon, it is concluded that antibody-producing cells are susceptible to the action of interferon. These data indicate that interferon has no general effect on host cell protein synthesis in the uninfected antibody-producing cell. (BBB)

41374 X-RADIATION-INDUCED DISTURBANCES OF RNA METABOLISM IN REGENERATING RAT LIVER. Berg, T. L.; Goutier, R. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). Arch. Int. Physiol. Biochim., 75: 49-56(1967).

The radiosensitivity of DNA synthesis in regenerating rat liver is well-known and can be ascribed partly to an inhibition of the neosynthesis of enzymes involved in DNA synthesis. An investigation was made of x ray effects on RNA synthesis as a first step in a more general study of the effect of irradiation on the protein-synthesizing apparatus of the cell. Widely different results have been obtained heretofore for radiation inhibition of RNA synthesis, according to the materials and the techniques used. Rats were x-irradiated (1000 R) one hr before partial hepatectomy and sacrificed at different times after surgery for determination of the in vivo rate of RNA synthesis. Nuclear RNA

of 12-hr regenerating liver was rapidly labeled after administration of ^{14}C-orotic acid, highest sp. act. being attained 25 min after injection. Thereafter a drop was observed and an almost constant labeling persisted during the next two hr. Incorporation into cytoplasmic RNA was very much slower, but increased steadily during the period studied. Ribonucleic acid synthesis in irradiated animals followed the same pattern, but the labeling of nuclear RNA was markedly slower and maximum sp. act. was not reached until 45 min after the injection of the labeled precursor. A small, but significant inhibition of cytoplasmic labeling was also noted. Fifteen hours after hepatectomy, the labeling patterns of nuclear RNA in two groups were identical but the labeling of cytoplasmic RNA was severely impaired in the irradiated animals. Thus the inhibitory effect of x irradiation was most easily detected in cytoplasmic labeling. Sucrose density gradient analysis revealed no significant difference in distribution for cytoplasmic RNA, whereas the inhibition was greatest in the highest molecular weight components of nuclear RNA. (BBB)

41375 NUCLEOTIDE COMPOSITION OF DNA IN BACTERIA AND THEIR SENSITIVITY TO GAMMA-RAYS. Samoilenko, I. I.; Ivanov, K. K. (Gamaleia Inst. of Epidemiology and Microbiology, Moscow). Byull. Eksp. Biol. Med., 63: No. 6, 43-6(June 1967). (In Russian).

The effects of γ radiation on the viability of a number of pathogenic and nonpathogenic bacteria of the intestinal group was studied. Clear-cut differences in their radiation resistance were shown. Determination of nucleotide composition of DNA by the method of round paper chromatography and by melting temperature showed that the bacteria studied have different index of DNA specificity. By comparison of radiation resistance and nucleotide composition of DNA, a general trend was shown; in more radiation resistant strains DNA contains a greater number of AT-pairs. (auth)

41376 CELLS AND TISSUES IN CULTURE: METHODS, BIOLOGY, AND PHYSIOLOGY. VOLUME 3. Willmer, E. N. (ed.). London, Academic Press, 1966. 826p. 168s.

This book contains a section on tissue culture in radiobiology by O. A. Trowell (Medical Research Council, Radiobiological Unit, Harwell, England). Subheadings of this section are: Historical introduction; effects of radiation on cell proliferation; effects of radiation on growth of tissue and cell cultures; effect of radiation on growth of isolated cells; irradiation of selected parts of cell; some fallacious methods of growth measurement; nonmitotic cell death; degenerative changes in cytoplasm; radiation and cell differentiation; radiosensitivity of malignant cells; chemical factors influencing radiosensitivity; effects of radiation on culture medium; comparison of in vitro with in vivo sensitivity; comparison of different sorts of ionizing radiation; effect of ultraviolet radiation. (UK)

41377 ELEKTROCHEMISCHE METHODEN UND PRINZIPIEN IN DER MOLEKULAR-BIOLOGIE. III. JENAER SYMPOSIUM 25. BIS 29. MAI 1965. VORTRAEGE UND DISKUSSIONEN. (Electrochemical Methods and Principles in Molecular Biology. 3rd Jena Symposium, May 25 to 29, 1965. Contributions and Discussions). Berg, Hermann (ed.). Abh. Deut. Akad. Wiss. Berlin, Kl. Med., No. 4, 1-648(1966). (CONF-650556).

Seventy-eight papers discuss various aspects of electron transport in biological systems. A separate abstract was prepared for one paper. (C.H.)

For an abstract of the individual paper see: 41518.

Ecology

Refer also to abstracts 41010, 41151, and 41186.

41378 (CONF-660827-2) ENRICHMENT OF RADIONUCLIDES BY FOODSTUFFS AND MAN IN ARCTIC, NUTRIENT-DEFICIENT REGIONS. Miettinen, J. K. (Helsinki Univ., (Finland). Dept. of Radiochemistry). [1966]. 18p. Dep. CFSTI.

From 7th International Congress on Nutrition, Hamburg, Germany.

In Arctic regions, efficient food chains of radioisotopes were elucidated leading from the slow growing lichens that take all nutrients from the atmosphere or rain to the reindeer, the meat of which is consumed in large quantities by the reindeer herding Lapps. Other food chains lead from the extremely pure lake waters to both plankton and fish, and to water plants like sedges and horsetails that are eaten by cows, and furthered to cow's milk. Radioisotopes having half-lives of several years are most efficiently enriched. Naturally occurring radioisotopes such as ^{210}Pb and ^{210}Po, and artificial fallout such as ^{137}Cs, ^{90}Sr, and ^{55}Fe, are accumulated in man. Since Pb and Sr are mostly located in the bones of reindeer that are not eaten by man, their enrichment is weak. Body burdens of ^{137}Cs 30 to 50 times higher than normal were measured by whole-body counting in Lapps, whose radioactivity was close to but not exceeding the maximum permissible level of three μCi set by the International Commission for Radiological Protection. Significance of the findings on food chains as well as experience on farming in Lapland in relation to man's nutrition in space are briefly discussed. (auth)

Genetics and Cytogenetics

Refer also to abstracts 41516, 41519, and 41522.

41379 EFFECTS OF X-IRRADIATION OF SEED ON X_1 AND X_2 GENERATIONS IN PINUS BANKSIANA LAMBERT. Rudolph, T. D. (U. S. Dept. of Agriculture, Rhinelander, Wis.). Radiat. Bot., 7: 303-12(1967).

Pinus banksiana (jack pine) seed x-irradiated at 1000 and 4000R was tested under commercial nursery and field planting conditions. At 4000R no seedlings survived beyond 1 yr of age. At the end of two years approximately 30 percent of the seedlings from seed given 1000 R survived as compared to the control. A decrease in LD_{50} exposure was noted as the seedlings aged; 2.25 R at 40 days, 1710 R at 130 days and 700 R at 14 months. The LD_{50} determined from the survival response curves was found to be linear over the first two growing seasons, permitting prediction of the dosage that would result in 50 percent plant survival at any point in the first 2 yr. Cone development and yield of X_2 seed/cone following self-pollination were reduced in the irradiated trees as compared to the controls. Seed germination, however, was higher in the seed from trees grown from the 1000 R irradiated seed than from the controls, suggesting an apparent stimulation of seed viability. Survival in the X_1 generation, and the quantity and quality of X_2 seed produced on X_1 trees, showed that the reproductive capacity was reduced by seed irradiation at 1000 R to slightly over 10 percent in cross-pollinated X_2 seed production, and to less than 5 percent after self-pollination. The results show that the effects of seed irradiation in jack pine, and probably other conifers, cannot be fully evaluated in a portion of the first generation, but that at least two generations are required. (auth) (UK)

41380 DEPENDENCE OF THE OXYGEN ENHANCEMENT RATIO ON NEUTRON ENERGY. Dennis, J. A.; Boot, S. J. (Atomic Energy Research Establishment, Harwell, Eng.). Nature (London), 215: 310-11(July 15, 1967).

Following on studies reported on oxygen enhancement ratios in human cell cultures subjected to neutron irradiation, studies are described on the induction of somatic mutation in the staminal hair cells of a diploid clone derived from a variety of Tradescantia occidentalis. The inflorescences of the plants were irradiated with 200 keV X-rays, ^{60}Co gamma rays, and mono-energetic neutrons of energy 0.1 to 14.7 MeV. Aerobic and anoxic exposures were made. Experimental details are described. For both X-rays and the gamma irradiation the results were well represented by curves of the type $M = \alpha + \beta D + \gamma D^2$, where M is mutation frequency and D the fluence. For neutron irradiations results fitted $M = \alpha + \beta D$. The dose rates for neutrons varied between 0.02 and 0.4 rad/min., depending on energy. Oxygen enhancement ratios as a function of neutron energy are shown graphically, and results are compared with those obtained by other workers. A high value for the oxygen enhancement ratio at 0.42 MeV is discussed. The studies demonstrated that heavy ion recoils must play an important part in the effect of neutron irradiation on tissue, and that possibly range as well as LET is a factor in the response. (UK)

41381 X-RAY INDUCED CLUSTERED-INFLORESCENCE MUTANT OF PHASEOLUS MUNGO. Jana, M. K.; Maitra, S. K. (Indian Inst. of Tech., Kharagpur, India). Sci. Cult. (Calcutta), 33: 237-8(May 1967).

A wide spectrum of mutants was obtained by x-irradiating dry seeds of Phaseolus mungo L; most of the mutations were observed in the X_2 generation. A new clustered-inflorescence mutant that was recovered is described. The mode of segregation in the X_3 generation of the mutant is also described. (B.H.S.)

41382 YIELD EFFICIENCY OF THE X-RAY MUTANT SVALOF'S PALLAS BARLEY. (A BIOMETRICAL ANALYSIS OF SOME DANISH DATA). Gustafsson, Ake; Ekman, Gunnar (Dept. of Forest Genetics, Stockholm). Zuechter, 37: 42-6 (Apr. 14, 1967).

Yield data are given for erectoides-32, an x-ray-induced mutant from Svalöf Bonus barley, isolated in the X_2 generation and corresponding to the gene locus ert-k. The radioinduced mutant was detected by its typical erectoides ear, although the erectoid character was not especially marked. It was found to be high yielding and superior to its parent variety in lodging resistance. Regarding

straw breakage at maturity and susceptibility to mildew, it reacted as its parent. A biometrical comparison of the two varieties was made with regard to grain yield, lodging resistance, straw height, and straw production. In addition, the influence of increased lodging resistance on yield as well as the variance of yield and lodging was analyzed. (BBB)

41383 RADIATION-INDUCED SOMATIC MUTATIONS AND THE LOSS OF REPRODUCTIVE INTEGRITY IN TRADESCANTIA STAMEN HAIRS. Nayar, G. G.; Sparrow, A. H. (Brookhaven National Lab., Upton, N. Y.). Radiat. Bot., 7: 257-67(1967). (BNL-11213).

Inflorescences of Tradescantia (clone 02), a diploid hybrid heterozygous for flower color, were given a 16-hr exposure (25 to 500 R) of ^{60}Co γ-rays from a 3200 Ci source. Morphological abnormalities induced in stamen hairs were noted for a period of 20 days and records kept of the frequency and position of mutant cells and mutant events and of the killing effect (loss of reproductive integrity) in the hairs. The results show that these effects are highly dependent upon the developmental stage of the hair at the time of exposure. Giant cells and abnormally shaped cells were induced both apically and interstitially at the higher levels of radiation exposures. Branching of the hairs was also observed. Such effects occur very rarely in unirradiated flowers. An increased number of mutant pink cells per stamen appeared about six days postirradiation. They increased with increasing exposure and time, reached a peak about 14 days after treatment, then decreased in number up to 20 days. The frequency of mutant events (single cell or multicellular mutations) per stamen reached the highest value for each exposure at about 10 or 11 days after treatment, leveled off, and declined after about 13 days. This indicates that at the time of irradiation these buds contained the maximum number of meristematic stamen hair cells. Mutation rate varied with exposure and time, but at 11 days after irradiation with 100 R it was estimated to be 5.29×10^{-4} per R per meristematic cell. The percentage of stunted hairs (those that had lost their reproductive integrity) per stamen showed an increase with increasing exposure, but at exposures up to 300 R some sort of recovery phenomenon was noticed. A typical exponential survival curve was found with a D_{37} of 270 R and an extrapolation number 1.81. Exposures of 200 to 300 R are optimal for producing mutations and are not sufficiently high to induce lethality to an extent that would mask the mutation sensitivity of stamen hair cells. The results indicate that there exists, over a limited time and within a certain exposure range, an approximately linear relationship between radiation exposures and the frequencies of mutant cells and of mutant events. (auth) (UK)

41384 MORPHOLOGICAL CHANGES AND RADIOSENSITIVITY OF MOUSE OOCYTES. Slizynski, B. M. (Inst. of Animal Genetics, Edinburgh). Curr. Mod. Biol., 1: 1-4(Mar. 1967).

Mammalian ova show three stages of radiosensitivity. Both the first and third periods of sensitivity are related to the condensed state of the chromosomes. The second sensitive period forms part of the dictyotene stage in which before the 7th and after the 21st day the oocytes are less sensitive to irradiation. Morphological analysis of oocytes of this second sensitive period was performed. Thus several differences in nuclear morphology between the radiosensitive and resistant oocytes, irrespective of their size or of their developmental age were found. Sensitive oocytes were characterized by nuclei with large, round, strongly strainable lumps, uniform granular network, absence of fuzzy lumps, and inconspicuous nucleoli. The fact that massive growth of the oocyte occurs in the postsensitive period indicates that the activities concerned with increase in size are not related to the radiation sensitivity. Thus, it is during the period of differentiation that the oocytes are highly sensitive. If the condensed state of the chromosomes is a condition of irradiation sensitivity, then in the sensitive, dictyotene oocytes the sensitivity would be limited to those regions in which condensation is present at time of treatment. The structural changes induced by irradiation during the sensitive period are expected to be regionally localized. (BBB)

41385 THE EFFECTS OF X RAYS ON THE CHROMOSOMES OF LOCUST EMBRYOS. IV. DOSE-RESPONSE AND VARIATION IN SENSITIVITY OF THE CELL CYCLE FOR THE INDUCTION OF CHROMATID ABERRATIONS. Fox, D. P. (Marischall Coll., Aberdeen, Scotland). Chromosoma, 20: 413-41(1967).

The G_2 and late S phases of the cell cycle in embryos of Schistocerca gregaria responded to irradiation by showing only chromatid aberrations at the first subsequent mitosis. The variation in yield of all chromatid aberration types during this period was studied. Chromatid aberrations could be subdivided into two distinct classes (a) achromatic lesions and (b) break and exchange aberrations. Achromatic lesions (both g and G types) decreased exponentially in yield during G_2 but showed a plateau or slight rise during S phase. Each break and exchange aberration revealed a unique pattern of variation of yield. These curves could be subdivided on the basis of their general shape into two groups: (a) those showing an early peak falling off to a plateau (c, m, c/c) and (b) those showing two peaks separated by a trough (SU + NU_p + NUd, NUpd, mm, c/i). The only consistent difference between these two subgroups was that (a) appeared structurally to involve the chromatid and (b) an isochromatid. Attempts were made to make dose response comparisons. Gap aberrations were distributed at random between cells at the later fixation times after 50 and 100 R, though at 150 R and at earlier fixation times after 50 and 100 R they were overdispersed. This may reflect cell mixing. If so, the greatest mixing did not occur at the peak mitotic index after irradiation. The random distribution of gaps between cells and their exponential decline during G_2 was consistent with random repair of gaps during G_2. However, there was no convincing evidence for gap repair. Various aspects of the relation of gaps to break and exchange aberrations were investigated. A consistent relation between gaps and type (b) aberrations was demonstrated. The ratio of gaps to this group of aberrations fell steadily during G_2 but was constant during that part of S phase investigated. Gap inflexions, gap associations and gaps associated with exchanged chromatids appear to reflect failure of the exchange process at various stages. (BBB)

Health Physics and Safety

Refer also to abstracts 40798, 40879, 40956, 40961, 40992, 41010, 41019, 41020, 41060, 41061, 41153, 41275, 41282, and 41449.

41386 (AD-647838) HUMAN FACTORS IN TACTICAL NUCLEAR COMBAT. Report No. Professional Paper 2-67. Vineberg, Robert (George Washington Univ., Alexandria, Va. Human Resources Research Office). Jan. 1967. Contract DA-44-188-ARO-2. 29p. CFSTI.

This presentation summarizes information in HumRRO Technical Report 65-2, (AD-463 787) which contains the results of a study undertaken as a Technical Advisory Service project upon request of the U. S. Army Combat Developments Command. The purpose of the study was to provide bases for predicting human behavior in nuclear warfare, the probable behavior of civilians as well as the probable effectiveness of soldiers. The research including an analysis of social, psychological, military, and training factors of particular significance for nuclear combat. In addition, a model was developed for adjusting casualty rates, based on psychological factors, for use in war gaming. The study was completed and reported to USACDC in September 1964. (TAB)

41387 (AD-649533) EVALUATION OF FALLOUT CONTAMINATION FROM SURFACE RUNOFF. Final Technical Report, November 6, 1965-June 10, 1966. Grune, Werner N.; Atlas, Henry S.; Hamel, Gerard J. (Merrimack Coll., North Andover, Mass. Div. of Engineering). June 1966. Contract N228(62479)-69779. 68p. CFSTI.

Previous studies of water supply contamination from fallout due to nuclear attack indicated that the level of activity brought into a water supply by surface runoff increases the activity considerably. These studies employed a constant value for the "runoff-coefficient" to obtain estimates of the degree of contamination resulting from the soluble fraction of fallout. This report summarizes known relationships between rainfall and the amount of activity that reaches the water supply due to surface runoff and is concerned mainly with the hydrology of surface runoff and ion exchange phenomena. Data on ion exchange properties of soils with respect to the biologically important radionuclides are given. Further, the report includes a consideration of the general problem of transport of activity, a discussion of uptake of activity by biota and preliminary calculations of water supply contamination for Providence, R. I., one of the cities in the OCD "5-City Study." Maximum levels of selected contaminants at the Providence water intake from a 30 MT attack indicate that the water supply contamination level may be increased by a factor of 10 to 25 when surface runoff from the watershed is considered. (CFSTI)

41388 (AD-649543) AMERICAN VIEWS ON CIVIL DEFENSE IN THE COLD WAR CONTEXT: 1966. Summary Report. Nehnevajsa, Jiri (Pittsburgh Univ., Pa. Dept. of Sociology). Dec. 1966. Contract OCD-OS-63-48. 154p. CFSTI.

An examination of Americans' views on civil defense in the 1966 cold war context from the point of view of the fundamental patterns and meanings of all available information and from the point of view of evaluating specific items of information was made. The 1966 data were obtained from a national sample of 1,497 Americans interviewed in February and March, 1966. In many cases, data are presented with comparable data from pre-

vious studies. There is a form of national consensus, with stability over time, in support of civil defense, and it is impossible to identify any particular segment of the population who express negative sentiments. The basic consistency in positive attitudes apparently has not been affected by fluctuations in the international environment, changes in the nation's administration, or shifts in Soviet leadership. Nor have major shifts in the civil defense programs themselves affected the national sentiment. Americans are convinced that survival odds would be greatly enhanced for a sheltered population. The shelter assignment notion meets with very little negative feeling. The home shelter survey idea is very well received. Americans see a significant role for civil defense in natural disaster and other emergency situations. While Americans do not consider civil defense to be among the most important problems facing the nation, among programs competing before Congress for financial support, civil defense is second only to higher education and national health programs. (TAB)

41389 (BNL-50005) HEALTH PHYSICS PROBLEMS OF HIGH ENERGY ACCELERATORS. Cowan, F. P. (Brookhaven National Lab., Upton, N. Y.). May 18, 1966. 14p. Dep. CFSTI. Brookhaven Lecture Series Number 57.

Accelerator radiation safety is discussed. Dosimetry methods, LET analysis, instrumentation, and quality factor determination are included topics. Future accelerator radiation safety problems are discussed. (W.H.K.)

41390 (COO-1097-24) GENETIC CONTROL OF PHYSIOLOGICAL PROCESSES IN HIGHER PLANTS. Technical Progress Report, 1965–1967. Rasmusson, D. C.; Smith, L. H.; Kleese, R. A.; Rust, R. H. (Minnesota Univ., Minneapolis). June 1967. Contract AT(11-1)-1097. 65p. Dep. CFSTI.

Progress is reported on studies on the inheritance of the capacity for ^{45}Ca and ^{89}Sr accumulation in grain of barley and wheat. Data are included from studies on the uptake of ^{89}Sr in various plant parts of normal and grafted soybeans, and genetic, metabolic, and physiological factors that influence the uptake of ^{89}Sr and nutrients from soil. The effects of soil properties, especially nutrient content, on the uptake of ^{89}Sr by barley and wheat from soils were also studied. Data are included from preliminary studies on the effects of the essential mineral elements, P, K, Ca, Na, Fe, Mg, Zn, Cu, Mo, Mn, and B, on the uptake of ^{89}Sr by plants. (C.H.)

41391 (KFK-551) MESSUNG DER OERTLICHEN VERTEILUNG DER STRAHLUNGSDOSIS IN DER UMGEBUNG DES KERNSFORSCHUNGSZENTRUMS KARLSRUHE MIT PHOSPHATGLASDOSIMETERN. (Measurement of the Local Distribution of Radiation Dose in the Environs of the Karlsruhe Nuclear Research Center with Phosphate Glass Dosimeters). Maushart, R.; Piesch, E.; Winter, M. (Kernforschungszentrum, Karlsruhe (West Germany)). Apr. 1967. 35p. (In German). Dep.

The accumulated dose in the environs of the Karlsruhe Nuclear Research Center was measured with phosphate glass dosimeters. The dose values obtained after a half years exposure at 100 measurement sites on the terrain boundary shows that except for isolated increases of the natural dose by stationary radiation sources in the nuclear center, no general effect of the nuclear installation could be established. The mean annual dose was obtained as 60 mR. Evaluation of the error shows that in a single year a local increase of the accumulated dose of about 20% is necessary in order to detect the presence of unnatural radiation sources. (tr-auth)

41392 (NP-16789) QUELQUES PROBLEMES POSES PAR L'APPLICATION PRATIQUE DES PRINCIPES FONDAMENTAUX DE RADIOPROTECTION DES TRAVAILLEURS. Etude Comparative des Legislations des Pays de la Communaute Europeenne. (Some Problems Posed by the Application of Fundamental Principles of Radioprotection of Workers. Comparative Study of Legislations of the European Community Countries). Carbone, Ferdinando (Paris Univ. (France). Institut de Droit Compare). 1966. 150p. (In French). Dep.

The legislative enactments implementing the treaty instituting the European Community of Atomic Energy are compared for the member nations — France, Italy, Belgium, Luxemburg, Germany, and the Netherlands. The normative production and legislative technique in the European community with respect to the radioprotection of workers are outlined. Some specific problems of the health monitoring of nuclear workers are considered. (J.S.R.)

41393 (NP-16856) RADIOLOGICAL HEALTH RESEARCH. Summary Report, July 1965–December 1966. (Public Health Service, Rockville, Md.). [1966]. 120p.

Progress is reported in radiation biology, epidemiology, and environmental sciences at the National Center for Radiological Health. Facilities and buildings of the five laboratories located in various parts of the United States and operated by the Division of Radiological Health are described. Studies on relationships between radiation dose and incidence of disease and disability in human population groups are being conducted. Field and laboratory studies are carried out to develop sensitive methods, techniques, and tools to detect and interpret biologic damage related to low-level radiation exposures. Studies of biochemical and structural cellular changes resulting from radiation exposure involve tissue and organ systems. Experiments with dogs on relations between radiosensitivity and age at the time of exposure are being conducted at Colorado State University. Studies of human chromosomal changes following diagnostic x rays and other types of exposure are being extended to various age groups. Biochemical measurements of DNA-related changes are being studied to provide indices of radiation effects in human population groups that are more sensitive than mortality and morbidity statistics currently used. The safety, feasibility, and effectiveness of various measures designed to prevent radionuclide contamination are also being studied. (H.L.W.)

41394 (NYO-3364-30) ^{137}Cs IN CARROTS IN NORWAY, FALL 1964 AND FALL 1965. Madshus, Kjell (Norsk Hydro's Inst. for Cancer Research, Oslo); Stroemme, Aksel (Norsk Radium Hospital, Oslo); Koren, Kristian (Statens Radiologisk-Fysiske Laboratorium, Oslo (Norway)). Contract AT(30-1)-3364. 10p. Dep. CFSTI.

Data are presented on the content of ^{137}Cs in carrots in Norway in 1964 and 1965. The average concentration of ^{137}Cs showed a marked decrease from 1964 to 1965. The content of ^{137}Cs varied considerably in carrots from different sections of the country and from the same section. (C.H.)

41395 (NYO-3364-35) ^{137}Cs IN MILK IN NORWAY, 1962–1967. Madshus, Kjell; Stroemme, Aksel; Koren, Kristian (Statens Radiologisk-Fysiske Laboratorium, Oslo (Norway)). 42p. Dep. CFSTI.

Data are presented on the content of ^{137}Cs in samples of cow's milk collected in Norway between March 1962 and March 1967. An overall decrease in ^{137}Cs content in milk was observed during the period. The ^{137}Cs content in milk from areas with high precipitation was greater than in milk from more arid regions. (C.H.)

41396 (ORNL-P-3227) SAFETY REVIEW PROCEDURES FOR HOT CELL AND RADIOCHEMICAL PROCESSING FACILITIES AT ORNL. Burch, W. D.; Arehart, T. A. (Oak Ridge National Lab., Tenn.). [1966]. Contract W-7405-eng-26. 15p. (CONF-671102-3). Dep. CFSTI.

For Presentation at 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill.

Responsibility for radiation safety of all hot cell and radiochemical processing facilities at ORNL is under the Director of Radiation Safety and Control, who has established uniform policies throughout the laboratory. Working with a full-time staff of three and with the help of standing review and advisory committees, adequate safety practices have been maintained such that no incidents of any consequence have occurred within the past seven years since the regulations were implemented. The organization and some of the established standards are herein described. (auth)

41397 (ORNL-TM-1981) HEALTH PHYSICS AND SAFETY GUIDELINES FOR THE DOSAR FACILITY. Kerr, G. D.; Poston, J. W.; Robinson, E. M. (Oak Ridge National Lab., Tenn.). Sept. 1967. Contract W-7405-eng-26. 13p. Dep. CFSTI.

Procedural guidelines for the safety of personnel at the Dosimetry Applications Research (DOSAR) Facility at ORNL are described. These include personnel control, monitoring, handling of radioactive material and equipment, and general safety. (L.C.L.)

41398 (SZS-5/67) DER ^{90}Sr-GEHALT IN BOEDEN UND PFLANZEN AUF DEM TERRITORIUM DER DDR, 1965. (^{90}Sr Content of the Soil and Plants From the Territory of the German Democratic Republic in 1965). Kunert, J.; Bose, H.; Scheel, H. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). June 1967. 33p. (In German). Dep.

The results of ^{90}Sr determinations in soil and plant samples taken from the territory of the G.D.R. in 1965 are reported. In contrast to the preceding years, in 1965 the collection of samples was performed on the basis of a revised program resulting in a lower number of sampling sites but an increased number of plant samples. The sampling sites are now more equally distributed in the territory of the G.D.R. than in the former program. Comparing the obtained results with those of 1964 an increase of the ^{90}Sr content was only observed in the meadow soils. The mean value has grown by 6 nCi/m^2 to 35 nCi/m^2. A lower mean contamination value (30 nCi/m^2) was obtained in agricultural soils. Two of these soils were investigated down to 50 cm. In the additionally examined

layers 10 to 20% of the ^{90}Sr quantity contained in the routinely analyzed layers were found. In 1965 again the following plant materials were examined: grass, clover and luzern, rye grain, potato (herb and tuber), cabbage (head and outer leaves), green maize, and beet (tops and body). Wheat grain was included into the investigations for the first time. In most of these plants the ^{90}Sr contamination continued to decrease. In the dry matter of plant materials it was 83% and referred to the Ca content it was 73% of the last year values. The estimated ratio of ^{90}Sr surface contamination to ^{90}Sr total contamination was lower than 0.5 for all investigated plant materials except for wheat grain. For wheat grain the ratio was 0.5. The portions of ^{90}Sr fallout and of ^{90}Sr accumulated in the soil taken up by the plants hardly differed from last year's values. (auth)

41399 (TID-5360(Suppl.1)(Rev.)) A SUMMARY OF INDUSTRIAL ACCIDENTS IN USAEC FACILITIES, 1956. (Division of Operational Safety (AEC), Washington, D. C. Industrial Safety and Fire Protection Branch). Aug. 1967. 21p. Dep. CFSTI.

A new edition of the original report that was published in 1957 is presented. Criteria are given for the 1956 incidents that are listed together with narrative descriptions of injuries and fatalities. (H.L.W.)

41400 (TID-24033(Vol.1)) A PROGRAM TO COMPUTE BETA RADIATION DOSAGE. VOLUME I. PROGRAM DESCRIPTION. Final Report. Curtis, Gale B.; Petty, Joan S. (American Research Corp., Fullerton, Calif.). Aug. 1, 1967. Contract N0022866C0330. 123p. (ARC-67-48). Dep. CFSTI.

American Research Corporation has developed a computer program to calculate beta radiation dosages to tissue incurred from contact with radioactive fallout particles containing mixed fission products. Versions of the Beta Radiation Dosage Program have been prepared for the CDC 3600 and IBM 7094 computers. Flexible input/output procedures provide control over the selection and arrangement of output parameters. Many tables, functions, and parameters, considered input quantities in most programs, have been incorporated into this program. These quantities may be treated as optional inputs where desired, however. Volume I contains the technical and programming approaches utilized and a general description of the program. (auth)

41401 (TID-24033(Vol.2)) A PROGRAM TO COMPUTE BETA RADIATION DOSAGE. VOLUME II. USER'S MANUAL AND PROGRAM LISTINGS. Final Report. Petty, Joan S.; Curtis, Gale B. (American Research Corp., Fullerton, Calif.). Aug. 1, 1967. Contract N0022866C0330. 204p. (ARC-67-49). Dep. CFSTI.

American Research Corporation has developed a computer program to calculate beta radiation dosages to tissue incurred from contact with radioactive particles containing mixed fission products. This program is capable of evaluating beta radiation dosages arising from contact with particles originating from a nuclear weapon detonation as well as particles resulting from the destruction of a nuclear propulsion reactor. Versions of the Program to Compute Beta Radiation Dosage have been prepared for the CDC 3600 and IBM 7094 computers. Flexible input/output procedures provide control over the selection and arrangement of output parameters. Many tables, functions, and parameters, considered input quantities in most programs, have been incorporated into this program. These quantities may be treated as optional inputs where desired, however. Volume II contains detailed instructions for the use of the program as well as program listings. (auth)

41402 (UCRL-50163(Pt.2)) PREDICTION OF THE MAXIMUM DOSAGE TO MAN FROM THE FALLOUT OF NUCLEAR DEVICES. II. ESTIMATION OF THE MAXIMUM DOSE FROM INTERNAL EMITTERS. Ng, Yook C.; Thompson, Stanley E. (California Univ., Livermore. Lawrence Radiation Lab.). Dec. 14, 1966. Contract W-7405-eng-48. 25p. Dep. CFSTI.

A method is described for estimating the maximum internal dose that could result from the deposition of fallout radionuclides released to the atmosphere. By means of this analysis one can identify the nuclides that could contribute most to the internal dose, and determine the contribution of each nuclide to the total dose. The biological exchangeable pool concept was used for the analysis. Using this approach, the passage of a radionuclide through the biosphere is presumed to be governed by the same factors that govern the distribution of the related stable isotopes within the biological exchangeable pool. It must be assumed, of course, that the radionuclide is biologically no more available than the related stable isotopes within the environment. The basic calculation required is an estimation of the unit-rad deposition for each radionuclide encountered. The unit-rad deposition F_1 is the minimum deposition that could result in a 30-year internal dose of 1 rad. Estimated maximum doses are calculated from F_1 and from known or predicted values of deposition. Two modes of entry into man are assumed: direct deposition on forage leading into the forage-to-cow-to-milk pathway, and deposition on the terrain followed by equilibration in the biological exchangeable pool, for which the soil-root pathway is required for entry into plants. The method is illustrated by calculations required to estimate the maximum 30-year internal dose to the whole body. (C.H.)

41403 (UCRL-70284) HEALTH PHYSICS AT THE LRL-LIVERMORE TRANSURANIC PROCESSING FACILITY. Denham, Dale H. (California Univ., Livermore. Lawrence Radiation Lab.). July 10, 1967. Contract W-7405-eng-48. 26p. (CONF-671102-4). Dep. CFSTI.

For Presentation at 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill.

An account of the LRL-Transuranic Facility and the operations conducted therein is presented. The Livermore facility is described, the health physics controls used to limit personnel exposure and to maintain the basic concept of complete confinement of the highly radioactive and radiotoxic materials are discussed, and some of the special hazards of handling the transuranium elements are enumerated. (auth)

41404 (JPRS-41259) MAXIMUM PERMISSIBLE LEVELS OF IONIZING RADIATIONS. Kimel', L. P.; Mashkovich, V. P. Translation of Chapter III from Zashchita ot Ioniziruyshchikh Izlucheniy, Moscow, 1966. 20p. (TT-67-31899). CFSTI.

Maximum permissible levels of radiation exposure are presented for persons working with radioactive substances and sources of ionizing radiations in the Soviet Union. Data are tabulated on maximum permissible doses for external irradiation of the whole body and internal irradiation of critical organs; maximum permissible dose and relative biological effectiveness of various types of radiation; maximum permissible levels of contamination of working surfaces, clothing, footwear, and hands during occupational exposure; and maximum permissible concentrations of 32 biologically-important radioisotopes in drinking water. Legislation in the Soviet Union governing the use of radioactive substances and sources of ionizing radiations are discussed briefly. (30 references.) (C.H.)

41405 DOSE EQUIVALENT OF IONIZING RADIATIONS. Keirim-Markus, I. B.; Popov, V. I. Izmer. Tekh., No. 6, 74-6(June 1967). (In Russian).

In 1962 the International Commission on Radiological Units and Measurements (ICRUM) recommended the use of a dose equivalent (DE) in estimating the radiation danger in mixed radiation fields. The DE was defined as follows: (DE = D × QF × DF. . . . .). Here D is the absorbed dose; QF is the merit factor; and DF is a distribution factor to take into account inhomogeneous distribution. The continuation marks indicate that other modifying factors can be added. The authors stated that the DE as defined is too indefinite, and that a concrete number is required in practice to define the degree of danger to man from a number of radiation sources. Hence, they defined DE as follows: DE = D × QF, or DE = $\int_{0}^{\infty} D(L)QF(L)dL$, where L is the linear energy loss of the charged particles. The DE can be defined as a quantity characterizing the radiation danger of continuous irradiation of man by mixed ionizing radiation. In this form the DE is uniquely defined and is reproducible, if QF(L) is known. (TTT)

41406 CHANGE OF ISO-DOSE DISTRIBUTION CONTROLLED BY DEFLECTION MAGNET CURRENT IN ELECTRON BEAM THERAPY. Ueda, Toshio; Mizutani, Taketoshi (Aichi Cancer Center Hospital, Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 26: 1526-30(Feb. 1967). (In Japanese).

A dose distribution could be altered by changing the direction of electron beam which is controlled by the deflection magnet current. When an electric current of the deflection magnet was zero, the maximum degree of declining angle was obtained in iso-dose distributions. The declining angle of the 90% level curve was 63 degrees at 31 MeV and 30 degrees at 20 MeV. Within ranges of a declining angle given by regulating the deflection magnet current under 4.5 kV, a desirable declining angle could be obtained. In a low-dose area, there were little effects of changing the deflection current. The lower the energy of electron beam, the smaller the declining angle of iso-dose curves. This method may be of use for clinical practice instead of the wedge filter. (auth) (NSA of Japan)

41407 MEASURING UNITS FOR IONIZING RADIATION DOSIMETRY AND RADIOPROTECTION. Keirim-Markus, I. B.; Kochetkov, O. A.; Moskalev, Yu. I.; Popov, V. I. Izmeritel. Tekh., No. 11, 18-19(Nov. 1966). (In Russian).

Until the introduction of new standards (in the case of the revocation of GOST 8848-63) it is necessary to follow the international recommendations (ICRU) and to use universally adopted units (rad, GeV, R). It is considered inexpedient to introduce unilaterally new units for the measurement of ionizing radiation. It is necessary to strive for agreement within the ICRU. (tr-auth)

41408 ON THE INDICATIONS FOR X-RAY STUDIES OF THE FEMALE GENITAL ORGANS FROM THE VIEWPOINT OF RADIATION INJURY. Dietz, W.; Huber, R.; Eggs, F. (Roentgeninstitut Dr. Eggs, Freiburg I.B.). Roentgenpraxis, 19: 29-33 (Feb. 1966). (In German).

Contrast studies are appropriate for malformations of the uterus, including uterus arcuatus and uterus duplex; however, they have little value for routine studies in uterine aplasia, since there is little genetic significance for any radiation injuries. The unavoidable irradiation received by the ovaries during hysterosalpingography is disproportionate to its diagnostic value. In these and similar studies x ray should be used only when other methods are not suitable. Roentgenological studies are usually justified for diagnosis of most fistulas of the internal gonads, or in synechias or atresias of the uterus. Dysmenorrhea, meno-metrorrhagia, mucosal hyperplasia, adenomyosis, polyps, and placental residua are not sufficient indications for hysterosalpingography in women of child-bearing age. Hysterography or hysterosalpingography are reasonable for chronic, inflammatory changes in the genitals only if the question of fertility has been resolved. Evidence of genital tuberculosis or chorionic epithelioma may justify hysterography. Except for abdominal pregnancy or the very rare interstitial pregnancy, hysterography should not be used for ectopic pregnancies. Usually, abdominal photographs without contrast media are enough to confirm the diagnosis. In tubular pregnancies hysterography or hysterosalpingography may induce hemorrhages or postoperative pelvoperitonitis. All direct x-ray studies should be performed with an image intensifier-television screen system. In addition, techniques that use hard radiation are valuable for reduction of the danger of radiation injuries, even though all damage cannot be avoided, in any case. (BBB)

41409 SHELTER POWER SYSTEMS: THEIR EFFECT ON ENVIRONMENTAL CONTROL. Trayser, D. A.; Flanigan, L. J. (Battelle Memorial Inst., Columbus, Ohio). ASHRAE (Amer. Soc. Heat., Refrig. Air-Cond. Eng.) J. 72: 246-54(1966).

Advantages and disadvantages of sources of power used in ventilation of fallout shelters are given. Some example of power sources are Diesel fueled compression-ignition engines, liquid petroleum gas fueled spark-ignition engines, and gas turbines. Other power requirements needed to sustain shelter occupants are manifested in electrical energy for lighting and communication, mechanical energy for ventilation, air conditioning, and water circulation, and heat energy for water and food heating and air conditioning. Various aspects of these sources of power are discussed. (H.L.W.)

41410 RELATIVE AND ABSOLUTE MEASUREMENTS OF ^{131}I ACTIVITY IN SOLID AND LIQUID PLANT SPECIMENS. Zaduban, M.; Praslichka, M.; Brutovskii, M.; Liptakova, G.; Vinklerova, O. (Inst. of Experimental Biology, Academy of Sciences, Kosice, Czech. Safarik Univ., Kosicz, Czech.). pp 69-79 of STI/PUB-137. (In Russian).

From FAO/IAEA Symposium on the Use of Isotopes in Plant Nutrition and Physiology Studies, Vienna, Austria, Sept. 5-9, 1966.

Iodine is normally present as a trace element in plants, in the form of ions or in combination with an organic component. So far, however, little attention has been paid to iodine in the investigation of physiological processes, even though it is known to support photosynthesis, for example, to improve nitrogen and carbohydrate exchange, and to promote plant concentration of other trace elements. Research on iodine metabolism began after the radioisotopes of iodine, particularly ^{131}I, was discovered in nature. From the standpoint of radio-ecology and plant health, it is important to determine in what processes iodine takes part in plants and, if it really is an essential element, how it affects those processes. Radioiodine makes possible a very precise investigation of physiological processes in plants; accordingly, methods of determining ^{131}I in plant material were developed. It is convenient to place methods of making relative determinations in liquid and solid specimens in one category. By means of calibration curves showing the relation between changes in count-rate and volume or density, specimens of different volumes or densities can be compared (β-radiation is normally used). Provided the general efficiency of the measurement is known, specimens measured by different methods can be compared. A second category includes methods of determining the absolute activity of solid and liquid specimens from standard samples. This can be done by using: the over-all efficiency of a measurement, if known; a calibration curve showing the relation between count-rate and activity; the external standard method; or the internal standard method. From relations so obtained, specimens of different volume and density can be compared. ^{131}I can be determined in a mixture of radionuclides by gamma spectrometry or by concentration and separation processes. The following methods are useful: chemisorption with AgI/Ag (96%): ion exchange with a liquid ion-exchanger (PTs-amine-KMs) (90%); ion exchange with a solid ion-exchanger (Vofatit SBV) (85%). Radioiodine can be extracted from solution by boiling in sodium hydroxide (NaOH) or, at temperatures lower than 50°C, by ultrasonic methods (also in NaOH solution). (auth)

41411 MOUSE IMMOBILIZER AND RADIATION SHIELD. Boutelle, J. Lynn; Oper, Don (Veterans Administration Hospital, Long Beach, Calif.). Lab. Anim. Care, 17: 253-4(Apr. 1967).

Readily available lead cylinders (used for shipment of radioisotopes) were utilized as mouse immobilizers, that permitted parts of the animal to be irradiated while the rest of the mouse remained shielded. Two cylinders, each three in. in in length, were used to make one holder. The solid ends were cut off and the cylinders welded together with an acetylene torch. A U-shaped opening, large enough to permit the tail or a limb to protrude, was cut in one cap and the cap placed on one end of the cylinder. This cap was held in place by a spring loop attached to the cylinder. The lead cylinder was firmly attached to a plywood base by means of a sheet metal band secured with metal screws. Corkboard glued to the plywood base at the capped end permitted immobilization of the tail or limb with tape. Six such cylinders could be placed on a circular board about 16 in. in dia, allowing the tumor-bearing tails or limbs of six mice to be irradiated simultaneously, while the rest of the animal's body remained well shielded. (BBB)

41412 WEATHER AND DISCHARGE DATA USED TO COMPUTE DOSE RATES FROM COASTAL DISCHARGES OF RADIOACTIVITY. Morgan, F. (Ministry of Agriculture, Fisheries, and Food, Lowestoft, Eng.). Nature (London), 215: 474-6 (July 29, 1967).

Some of the waste material discharged into the sea from the Dounreay reactor establishment settles on the nets used by fishermen in the area. The dose rate to their hands is a function of the discharge rate and the local conditions around the fishermen's nets. Equations derived on this basis show a close agreement with findings in the field. (auth) (UK)

41413 DERIVATION AND EXPERIMENTAL VERIFICATION OF AN EQUATION FOR EXPOSURE-DOSE RATE DUE TO X-RAY CONTINUA. Ray, Satyabrata; Dodd, C. G.; Muchow, G. M.; Neilson, G. F.; Kaup, D. J. (Owens-Illinois Technical Center, Toledo, Ohio). J. Appl. Phys., 38: 3122-6(July 1967).

An equation has been derived for the exposure–dose rate due to radiation emitted by x-ray tubes and transmitted through media that absorb all characteristic radiation. The parameters involved are the operating voltage and current of the tube and the linear-absorption coefficient and thickness of the absorbing media. Experimental verification of the equation shows that exposure–dose rates can be calculated within ±6% on a relative basis. (auth)

41414 SAMPLING VARIABILITY IN RADIONUCLIDE CONCENTRATIONS IN PLANTS NATIVE TO THE COLORADO FRONT RANGE. Remmenga, E. E.; Whicker, F. W. (Colorado State Univ., Fort Collins). Contract AT(11-1)-1156. Health Phys., 13: 977-83(Sept. 1967).

Concentrations of gross gamma radioactivity and individual radionuclides were measured in twelve species of native plants which were collected in the Colorado Front Range in 1963 to 1964. Replicate collections from established plots were carried out in order to secure estimates of plot sampling variability. For gross gamma radioactivity and individual radionuclides, most of the species studied had coefficients of variation within the range of 9 to 22%. In general, low-growing forms such as grasses and forbs were more variable than shrubs, which in turn were more variable than trees. Many species exhibited plot variances that differed among sampling locations and dates. The changes in variances with dates appeared to be related to phenological stages of the plants. Most of the data appeared to be distributed log-normally. Data suggested that pooling tends to decrease within-plot variability. Laboratory and counting variances averaged less than 19% of the plot sampling variances. Heterogeneous variance among plots and among species was more common for ^{137}Cs than for the other nuclides studied. (auth) (UK)

41415 THE USAGE OF RADIOACTIVE LUMINOUS COMPOUND AND THE NEED FOR BIOLOGICAL MONITORING OF WORKERS. Vennart, J. (Radiological Protection Service, Sutton, Eng.). Health Phys., 13: 959-64(Sept. 1967).

The use of radioactive luminous paints gives rise to irradiation of luminisers and the public using the luminised articles. As far as the public is concerned, radionuclides which do not emit penetrating radiations, such as tritium and promethium-147, are more suitable materials than radium. Experience in the United Kingdom of monitoring luminisers for radium and tritium in their bodies is reviewed and discussed in relation to the possible use of promethium-147. Present conditions in the luminising industry

are such that there is a need for regular monitoring of workers, and the problems created by tritium and promethium-147 are sufficient to restrict their use, probably in favor of radium. There is thus a conflict between what is desirable from the point of view of the public and what is practiced by the industry. In order to resolve this dilemma it is suggested that the methods employed for luminising should be brought up to much higher standards for containing the radioactive compounds. (auth) (UK)

41416 THE DESORPTION OF ^{144}Ce TRACES FROM COTTON FABRIC TO THE SOLUTIONS OF SODIUM HEXAMETAPHOSPHATE AND PYROPHOSPHATE. Bar, Jaromir; Hala, Miloslav; Lahky, Ervin (Military Academy, Brno). Jad. Energ., 13: 330-2(Sept. 1967). (In Czech).

The influence of sodium hexametaphosphate and tetra-substituted sodium pyrophosphate on the desorption of traces of ^{144}Ce adsorbed on cotton fabrics is discussed. The percentage of desorption was determined as a function of pH and concentration of desorbing solutions. (tr-auth)

41417 ATMOSPHERIC DIFFUSION IN THE ANALYSIS OF NUCLEAR RISKS. Santos, Agustin Alonso (Junta de Energia Nuclear, Madrid). Energ. Nucl. (Madrid), 11: No. 45, 37-45 (Jan.-Feb. 1967). (In Spanish).

The equations used to evaluate the atmospheric diffusion in the analysis of nuclear risks are presented. Escape of gaseous products at ground level and at chimney level is considered. Partial results from the numerical evaluation of the equations are presented. The methods used for the determination of the meteorological parameters are outlined. (J.S.R.)

41418 ESTIMATION OF RADIATION DAMAGE IN THE ANALYSIS OF RISK OF NUCLEAR INSTALLATIONS. Alonso Santos, Agustin (Junta de Energia Nuclear, Madrid). Energ. Nucl. (Madrid), 11: 121-9(Mar.-Apr. 1967). (In Spa).

The equations derived previously make it possible to estimate the contamination produced near nuclear installations because of the escape of fission products or activation. The expressions used to evaluate the external dose caused by β and γ radiation and resulting from contamination of the soil are discussed. The dose received by specific organs (thyroids, bone, lungs, and the various parts of the digestive tracts) by inhalation of radioactive substances are evaluated and the results are tabulated. The physiological data necessary to apply the equations described are discussed. (J.S.R.)

41419 THE DEPOSITION OF 0.5 μ DIAMETER AEROSOLS IN THE LUNGS OF MAN. Muir, D. C. F.; Davies, C. N. (London School of Hygiene and Tropical Medicine). Ann. Occup. Hyg., 10: 161-74(July 1967).

A method is described for the measurement of the fractional deposition of aerosols in the lungs of man during steady-state breathing. The aerosol concentration was measured close to the mouth by a Tyndallometer with a small dead space and the inhaled and exhaled air volumes were measured with a spirometer. The factors affecting the deposition of unit density spheres of about 0.5 μ dia were investigated in three normal subjects. The fractional deposition rose with increasing tidal volume and fell with increasing frequency of breathing. The effect of changes in the tidal volume was surprisingly small and the possible reasons for this are discussed. The deposition values obtained were lower than those previously reported in the literature and suggest that during exercise the fractional deposition of 0.5 μ dia particles is about 10 percent of the inhaled concentration at all work loads. The importance of distinguishing between the effects of changes in the depth of breathing and in the frequency of breathing in the design of aerosol inhalation experiments is stressed. (auth) (UK)

41420 EVALUATION OF THE RISKS IN THE PROCESS FOR THE PRODUCTION OF URANIUM TETRAFLUORIDE. De Los Santos, F.; Iranzo, E. (Junta de Energia Nuclear, Madrid). Energ. Nucl. (Madrid), 11: No. 45, 21-34(Jan.-Feb. 1967). (In Spanish).

Each of the steps in the industrial production of uranium tetrafluoride is analyzed in order to determine the risks of each. The dangers in each step are evaluated and the most adequate means of protection are established. (J.S.R.)

41421 ^{14}C AND TRITIUM MEASUREMENT BY MEANS OF BREMSSTRAHLUNG EMISSIONS. Rosen, Jerry C.; Laurer, Gerard R.; Eisenbud, Merril (New York Univ., New York). Science, 157: 77-8(July 7, 1967).

The feasibility of measuring carbon-14 and tritium in vivo was demonstrated in the rat; thin scintillation detectors were used for the measurement of bremsstrahlung produced by these soft beta emitters. Measurements of tritium in vivo are limited to the study of surface phenomena, whereas bremsstrahlung produced by carbon-14 may be detected from depths of several centimeters. (auth)

41422 INVESTIGATIONS ON THE DIFFERENTIATION OF ^{90}Sr CONTAMINATION PROCESSES IN RED CLOVER, LETTUCE, AND SPINACH UNDER THE FALLOUT CONDITIONS IN THE YEARS 1961–1963. Reissig, Herbert (Technische Univ., Dresden). Albrecht-Thaer-Arch., 10: 1101-9(1966). (In German).

The percentage of ^{90}Sr surface contamination in the ^{90}Sr contamination total was determined in naturally sheltered and in unsheltered plants (red clover, lettuce, and spinach) for the period between 1961 and 1963. Surface contamination accounted for the greatest part of the strontium-90 total in the unsheltered variants of red clover, lettuce, and spinach, under the fallout conditions of 1962/63 (61 to 83% in red clover, 1962; 71 to 89% in red clover, 1963; 60 to 73% in lettuce, 1962; 89 to 92% in lettuce, 1963; 72 to 83% in spinach, 1962; 73 to 93% in spinach, 1963). The percentage of ^{90}Sr surface contamination of the first and second cuts of red clover, unsheltered variant (harvested August 1st or October 1st, 1961), i.e., under the fallout conditions of 1961, was 37 or 41%, respectively, while the third cut, harvested on December 1st, 1961, already indicated a value as high as 83 percent. This finding reflected the increase of ^{90}Sr fallout which occurred after the beginning of the test series of September, 1961. Lettuce and spinach were not examined in 1961. The sheltered variants of red clover, lettuce, and spinach got all their strontium-90 through surface contamination, in all the test years. The mechanism of contamination may be explained by the occurrence of dry deposits as well as by drifting fog drops. The probability of surface contamination of the sheltered variant through fresh fission nuclides was established. The ^{90}Sr surface contamination of the sheltered red clover variant (expressed in percent of absolute ^{90}Sr surface contamination of the unsheltered variant) varied between 15 and 41% in 1961; between 9 and 12%, in 1962; and between 5 and 19% in 1963 (average percentage for the three years under review being 16 percent). The variations of the same values were 17 to 35 percent for lettuce, in 1962/1963 (average 24 percent), and 14 to 24 percent for spinach, in 1962/1963 (average 18 percent). These results would permit the conclusion that rain was the major source (some 80 percent) of ^{90}Sr surface contamination of the plants tested. (auth)

41423 RADIATION DOSE FROM ELECTRON VACUUM TUBES OF A RADAR STATION. Stykan, O. A. Voenno-Med. Zh., No. 7, 36-8(July 1967). (In Russian).

The soft x-ray dose from radar electron tubes was determined by film dosimetry on the personnel at the station. The highly sensitive x-ray film was encased in a light-proof paper and was placed in a special plastic case. Film readings on 35 people were taken at various places over a period of 40 to 87 days of actual operation. The electron tubes operated from 21 to 112 hours. The degree of film blackening was determined on a densitometer. The results showed that the radiation intensity exceeded allowed levels at several locations. Thus, the total x-ray dose for 21 hr was 5 R and for 6 hr it was 0.5 R. These values correspond to dose rates of 238 and 83.3 mR/hr, which are to be compared with a maximum permissible dose rate of 0.2 mR/hr. No radiation dose at the normal working places of the personnel could be detected, since the radiation sources were shielded adequately. (TTT)

41424 DETERMINATION OF ENVIRONMENTAL FACTORS FOR MEASUREMENTS OF EXTREMELY LOW DOSE-RATE γ RADIATION ($10^1 \sim 10^2$ μr/hr). Rho, Chae-shik (Atomic Energy Research Inst., Seoul). New Phys. (Korea), 6: 76-85(Dec. 1966). (In Korean).

Measurements made on the dose-rate of environmental background gamma radiation in the vicinity of Seoul by means of a gammagraph are discussed. Results indicated that annual and daily variations of environmental gamma dose-rate were closely related to those variations of emanation and their daughter products concentration in air at ground level; a nearly complete cycle was shown. Day-time minimum was found to be expressed by an exponential function of day-time maximum mixing depth; maximum values were not always characterized by still air held within the ground inversion. An optimum period of time for calibrations and/or measurements of extremely low dose-rate gamma radiation ($10^1 \sim 10^2$ μR per hour) is given. (auth)

41425 PROTECTION FROM IONIZING RADIATIONS: A REVIEW OF THE REGULATIONS. Mullett, G. W. (Royal Hospital, Wolverhampton, Eng.). Ann. Occup. Hyg., 10: 269-76(July 1967).

It is stated that five years' experience of the relevant legislation has shown that while much of the radiation protection in industry is adequately provided without undue disruption of the industrial process, difficulties do arise which cause concern. The time is now opportune to examine the regulations in the light of this experience and ask whether they are adequately performing their function. It is suggested that some of the requirements of the regulations are over-stringent, causing unneces-

sary interference with industry. In the light of this experience the appropriate parts of the regulations should be revised to allow greater flexibility without causing any significant increase in the radiation hazard. (auth) (UK)

41426 CONCENTRATION AND TRANSPORT OF ^{32}P AND ^{65}Zn BY COLUMBIA RIVER PLANKTON. Cushing, C. E. (Battelle Memorial Inst., Richland, Wash.). Liminol. Oceanogr., 12: 330-2(Apr. 1967).

Plankton samples were collected twice monthly from several stations along a transect across the Columbia River. Two composite water samples were taken from the sampling stations for chemical analyses after filtration. Dissolved ^{32}P and ^{65}Zn were determined in the second sample after further concentration and organic chemical extraction. The seasonal patterns of ^{32}P and ^{65}Zn concentrations in net plankton are shown by means of a graph. Lowest seasonal values coincided with spring-summer high water period. Another graph shows the seasonal pattern of net plankton biomass/m^3 of water and the amount of associated ^{32}P and ^{65}Zn; lowest values occurred during the fall and winter. The radioactivity associated with plankton at the study site was approximately 1 to 2% of the total river transport of ^{32}P and ^{65}Zn. (H.L.W.)

41427 BIOPHYSICAL INVESTIGATIONS ON THE INCORPORATION OF NATURAL RADIOACTIVE EMANATIONS AND THEIR DECAY PRODUCTS. Pohl, Egon (Univ., Innsbruck. Osterreichische Akademie der Wissenschaften, Vienna). Oesterr. Akad. Wiss. Math.-Naturwiss. Kl., Sitzungsber., 174: 309-442 (1965). (In German).

A detailed description is given of the distribution, dosimetry, and biological effects of the radioactive gasses ^{222}Rn and ^{220}Rn and their daughter products when incorporated into guinea pigs or man by inhalation or through contact with bath water. (64 references.) (C.H.)

41428 DEPTH DOSES DUE TO FISSION NEUTRON SPECTRUM IN A TISSUE-EQUIVALENT MATERIAL. David, Lubomir (Inst. of Nuclear Research, Czechoslovakian Academy of Sciences, Prague). Jad. Energ., 13: 241-5(July 1967). (In Czech).

Accurate knowledge of fluence-dose relation is needed in neutron monitoring for radiological protection. Fluence-dose conversion factors for the depths of 0, 5, 10, 20, and 30 cm in an infinite slab of tissue-equivalent material are given and their dependence on neutron energy over the range of 0.1 keV to 10 MeV is determined. In addition, average values of these conversion factors for fission neutron spectrum as a function of its threshold energy are calculated and intercomparisons of several activation integrators as to their efficiency of measuring fast neutron tissue-doses are discussed. (auth)

41429 THERMOPLASTIC MATERIAL. Chameroy, Jean (to Groupement Atomique Alsacienne Atlantique). British Patent 1,081,983. Sept. 6, 1967. Priority date Feb. 3, 1965, France.

A thermoplastic material having a response equivalent to that of organic tissues with respect to β, γ, and x radiations and fast neutrons, consisting of polypropylene or polyethylene in an amount of from 55 to 70% by weight, polyoxymethylene in an amount of from 10 to 15% by weight, and magnesium oxide or magnesium hydroxide in an amount of from 20 to 30% by weight is discussed. (B.G.D.)

41430 RADIOAKTIVNYI KOBAL'T ^{60}Co. (Radioactive ^{60}Co). Sinitsyn, V. I. Moscow, Atomizdat, 1967. 112p.

A brief review (35 bibliographies) on the preparation of ^{60}Co is presented. Safety measures that should be followed by personnel during handling, storage, and transportation of ^{60}Co are discussed. Descriptions of large industrial γ-radiation facilities are also included. (R.V.J.)

41431 PESTICIDES AND POLLUTION. Mellanby, K. London, Collins, 1967. 221p. 30s.

This book contains a section on radiation pollution of the environment. (UK)

41432 INHALED PARTICLES AND VAPOURS. II. Proceedings of an International Symposium, Cambridge, England, 28 September–1 October 1965. Davies, C. N. (ed.). New York, Pergamon Press, 1967. 617p. $21.50. (CONF-650906).

The 48 papers presented at the symposium and subsequent discussions are presented. Applied and basic aspects of inhaled particles and vapors are covered. Included are papers on anatomy and physiology; coal dust in human lungs; evaluation of dust exposure; lung clearance and deposition in man; lung clearance in animals; and pulmonary response to dust: airway changes, and reactions to silica. (B.H.S.)

Medicine

Refer also to abstracts 41151 and 41492.

41433 CONFORMATION PLANIGRAPHY. Scott, W. P. (Charlotte Memorial Hospital, N. C.). Invest. Radiol., 2: 259-61(July-Aug. 1967).

A theoretical concept of linear planigraphy plus proof of how it can be effected is presented. Synchronous collimation of the beam to conform to the dimensions of an anatomical structure is illustrated. It was concluded that use of conformation planigraphy in radiodiagnostic procedures increased detail with less exposure to the patient. (B.H.S.)

41434 CHEST X-RAY FILMS AND MASS SURVEYS. Moseley, Robert D. Jr. J. Amer. Med. Ass., 200: 734(May 22, 1967).

Use of x rays routinely to screen cases of tuberculosis among patients admitted to hospitals is discussed in terms of the radiation exposure of and hazards to the patient. Because of ease, accuracy, and low cost, mass chest radiography with photofluorographic techniques is a useful tool in tuberculosis case finding in certain populations. The Joint Committee on Chest X-Ray of the American College of Radiology and the American College of Chest Physicians, recognizing that the diagnostic yield of routine hospital admission chest films in adults is still high, especially in metropolitan areas, and that the dangers from radiation are negligible, recommends continuation of routine hospital admission chest films where this procedure is now done and initiation of it where it is not. The accuracy of chest photofluorography is relative; in certain cases this method cannot distinguish tuberculosis. However, it is still an efficient method of case finding and a possibility of detecting other abnormalities in the chest. While the somatic and genetic harm from radiation in a properly taken chest radiograph is infinitesimal, it is good medical practice to keep to a minimum the amount of ionizing radiation expended. Each apparatus should be checked by competent and specially trained persons and all parts of the system carefully chosen to minimize the radiation hazard. The maximum amount of radiographic information with a minimum dose of ionizing radiation is obtained by the regular 14 × 17 in chest film. However, photofluorograms made with modern mirror optical systems are next best in efficiency and are completely satisfactory from the standpoint of case finding and acceptably low exposures to ionizing radiation. (BBB)

41435 RADIOTHERAPY FOR ACNE AND THYROID CARCINOMA. Weakley, David R. J. Amer. Med. Ass., 200: 900 (June 5, 1967).

Brief comments are made concerning radiotherapy-induced thyroid cancer. It is pointed out that without proper shielding of the neck the thyroid gland may receive undetermined amounts of irradiation. The case histories are reviewed of five patients who had received x-ray therapy for acne vulgaris in adolescence, and developed thyroid carcinoma years later. It is pointed out that because a causal relation between incidental irradiation of the thyroid and carcinogenesis cannot be disproved, radiation therapy for acne and other benign diseases of the head and neck should not be abandoned in the adolescent patient since mutilating acne vulgaris is a major medical problem deserving of sympathetic medical care, and one that sometimes requires x-ray therapy for control. It is suggested that no existent evidence incriminates x-ray therapy given for acne as a cause of thyroid cancer if the gland is shielded in the standard fashion. (BBB)

41436 HYDROGEN PEROXIDE AND IRRADIATION OF TUMORS. Chasin, W. D.; Gross, C. C.; Wang, C. C.; Miller, D. (Massachusetts Eye and Ear Infirmary, Boston). Arch. Otolaryngol., 85: 151-5(Feb. 1967).

Before applying regional intra-arterial infusion of hydrogen peroxide and external irradiation in patients with cancers of the head and neck, this technique was evaluated in animal tumors. Rats with ascites tumor were observed for a long period of time, taking into account the factor of spontaneous tumor regression, and employing control animals treated with x-ray therapy alone. The purpose was to determine whether a smaller amount of irradiation used in conjunction with peroxide infusion would cause as much tumor regression as a larger dose of irradiation alone. The peroxide infusion was begun 30 to 50 min before irradiation. The tumor contralateral to the side which was cannulated was treated with a single dose of x ray during the last few minutes of the infusion. In general, it was found that the initial results were good, especially in the range of 1250 to 2000 R. After 10 days, however, two untreated tumors regressed spontaneously in the 750 to 1500 R groups. In rats which received tumor irradiation concurrently with peroxide infusion, especially in the range of 900 to 1500 R, peroxide did not potentiate external irradiation. Thus, these experiments failed to confirm the potentiation of radiotherapy by regional intra-arterial infusion of hydrogen per-

oxide. Clinical studies in a few patients were similarly discouraging. The concept of potentiating the lethal effect of x ray by oxygenation of the cells is well grounded. The problem, however, seems to lie in the difficulty in oxygenating anoxic portions of a solid tumor by any technique which relies on vascular transport of oxygen to the tumor. As long as portions of a tumor remain isolated from the regional circulation there are anoxic and hypoxic cells. The incomplete destruction of hypoxic cells may result in local recurrence although irradiation has destroyed the portions which are well oxygenated. (BBB)

41437 RADIOACTIVE GAS TECHNIQUES IN THE MEASUREMENT OF REGIONAL LUNG FUNCTION. West, John B. (Postgraduate Medical School, London). Picker Clin. Scintill., 9: No. 6-C, 1-8(Sept. 15, 1965).

Radioactive gases were used to measure blood flow and ventilation of small regions of the lung without discomfort to the patient. Carbon dioxide labeled by ^{15}O is inhaled and the subject holds the breath for ten seconds. Scintillation counters are arranged over the the front and back of the lungs; ventilation per unit volume is compared in different regions of the lung, and the slope of the rate-meter tracing is used as a measure of regional blood flow. Xenon-133 is dissolved in saline and injected into the superior vena cava; when the gas reaches the pulmonary capillaries it is evolved into alveolar gas. Various methods of measuring distribution of radioactivity are described. Graphs are presented to show topographical distribution of blood flow in the lungs. Effects of change of posture and exercise on distribution of blood flow are also shown by means of graphs. Blood flow and ventilation are unevenly distributed in the lungs and these distributions are modified by heart and lung disease. The use of radioactive gases for measurement of these distributions is a definite improvement over older techniques. (H.L.W.)

41438 SERUM ALPHA GLOBULIN FRACTION: SURVIVAL-AND-RECOVERY EFFECT IN IRRADIATED MICE. Hanna, M. G. Jr.; Nettesheim, P.; Fisher, W. D.; Peters, Leona C.; Francis, Mary W. (Oak Ridge National Lab., Tenn.). Science, 157: 1458-61(Sept. 22, 1967).

An alpha macroglobulin fraction (19S) was isolated from the serum of rats and BC_3F_1 mice by zonal ultracentrifugation. Both the isologous and heterologous macroglobulin fractions increased survival among BC_3F^1 mice x-irradiated with 750 R. The mouse macroglobulin fraction also enhanced radiation recovery of hematopoietic tissue as measured by colony-forming assay and ^{59}Fe incorporation into erythropoietic cells. The overall difference in hematopoietic activity in the irradiated (400 R) mice treated with the macroglobulin fraction, in comparison with this activity in the controls, was three- to fivefold in the bone marrow and nine- to tenfold in the spleen between days four and seven after irradiation. This effect was not obtained with the isologous serum protein fraction containing proteins of smaller molecular weight. (auth)

41439 IN VIVO STUDIES OF RADIOACTIVE PHOSPHORUS IN MALIGNANT TUMOURS. Bleehen, N. M.; Bryant, T. H. E. (Middlesex Hospital, London). Clin. Radiol., 18: 237-44(July 1967).

A method is described for the continuous in vivo recording of radioactivity in animal tumours following the administration of ^{32}P. The effects of hormone administration and endocrine surgery have been studied on the ^{32}P uptake of 20 methylcholanthrene induced rat mammary tumours, and a comparison is made with similar observations in human tumours. Significant changes in activity have been observed, some of a periodic nature. The possible mechanisms are discussed, and caution in the interpretation of the results emphasised. (auth)

41440 RADIOCARDIOGRAPHIC FORMULA FOR THE CALCULATION OF THE AREA OF THE STENOTIC MITRAL VALVE. Megahed, Gamal E.; Senna, Gamal A. (Cairo Univ.). J. Nucl. Med., 8: 461-74(June 1967).

Twenty-three patients with pure mitral stenosis were studied with radiocardiography and their mitral valve area (MVA) measured by the surgeon during commissurotomy. A significant correlation existed between two radiocardiographic informations and the mitral valve area. These were the fractional stroke volume per square meter of body surface area ($FCO/P/m^2$) and the pulmonary circulation time (PCT). Since these two parameters vary in opposite directions, a quotient (Q) combining them as: $[(FCO/P/m^2)/PCT] \times 100$ was suggested and was found to show a higher and more significant correlation with the mitral valve area. From this quotient, a radiocardiographic formula for the calculation of the area of the stenotic mitral valve was derived. This formula is: MVA (cm^2) = $0.0645\ Q - 0.01$. The formula was shown to be able to calculate the mitral valve area in patients with mitral stenosis within the reasonable standard error of 0.2 cm^2 and showed a reasonable reproducibility on duplicate estimations. Although it could not be checked, it could also calculate the mitral valve area in the 23 patients studied after commissurotomy and in 12 normal subjects within a reasonable range. (auth)

41441 FALSE-POSITIVE HEPATIC SCAN. Johnson, Philip M.; Sweeney, William A. (Presbyterian Hospital, New York). J. Nucl. Med., 8: 451-60(June 1967).

Scintillation scans of the liver falsely suggestive for intrahepatic mass lesions were encountered in 7 of 24 cirrhotic patients undergoing porta-systemic anastomosis for portal hypertension. The false-positive hepatic scans resulted from regionally reduced or absent radioactivity. Several mechanisms that apparently contribute to the false-positive scan are discussed. Clues to its detection are found in the presence of significantly increased extrahepatic radioactivity. Colloidal radiopharmaceuticals are therefore recommended for hepatic scanning. (auth)

41442 CLINICAL RESULTS WITH A COLOR-RECORDING RESCANNER. Uchiyama, Guio; Hitchcock, A. A. C.; Morris, A. C. Jr. (Oak Ridge Inst. of Nuclear Studies, Tenn.). J. Nucl. Med., 8: 437-43(June 1967).

A method of combining color-recording and rescanning is described. A sensing and color-wheel system, both contained in the same small metal box, was used to rescan white photoscan records containing information about radioisotope concentration (expressed as film density). Advantages of the method were that difficulties involved with color-scanning a patient were avoided, small variations in counting rate were better shown than in the black and white scan, damage to the original method during analysis was avoided, some of the statistical raggedness was made more smooth, contrast could be refreshed, the instrument was simple to operate, and it was inexpensive to construct. Limitations and disadvantages of the method were discussed. (M.M.B.)

41443 MODIFICATION OF A MULTI-ISOTOPE COLOR SCANNER FOR MULTI-PURPOSE SCANNING. Ben-Porath, Moshe; Clayton, Clenn; Kaplan, Ervin (Loyola Univ., Hines, Ill. Univ. of Illinois, Chicago). J. Nucl. Med., 8: 411-25 (June 1967).

A simple method is described by which a standard color scanner may be converted into a multi-isotope scanner. The distribution of each isotope may be recorded in either positive or negative modes or combinations of the two. Up to three isotopes may be scanned simultaneously. Various clinical applications of this system are demonstrated. (auth)

41444 EXPERIENCES WITH A SOLID STATE DETECTOR FOR SURFACE COUNTING OF ^{32}P. Pircher, Felix J.; Anderson, Banks Sr.; Cavanaugh, Patrick J.; Sharp, Kathryn W. (Duke Univ., Durham, N. C.). J. Nucl. Med., 8: 444-50(June 1967).

The possibility of using solid state detectors in place of miniature GM tubes for monitoring ^{32}P turnover in superficial lesions of the skin and the eye has been explored. This paper describes the instrument and its characteristics and discusses the results of its application to the differentiation between malignant and benign superficial lesions. Measurements were made with a surface barrier type detector with a depletion depth of 300 microns (ORTEC-SBB-7007-300). The detector was made of hyper-pure, n-type silicon, which forms a junction with a Mylar window measuring 0.65 cm in dia and 0.5 mg/cm^2 in thickness. The device was housed in a gold plated brass can 2.24 cm long and 0.8 cm in dia. Electrons penetrating the window deposited their charges in the detector. These charges were collected at the signal pin and converted into a pulse which was transmitted down the center conductor and through a four-foot long coaxial Micro Dot Mininoise cable into an amplifier. After amplification, the pulses were routed through the low level discriminator. Both amplifier and discriminator were housed in model ORTEC-207. The pulses which exceeded a preset discriminator level were fed into a scaler. The detector bias was set at 10 V and the discriminator level at 75 keV. (auth)

41445 COMPARATIVE STUDY OF RESULTS OBTAINED WITH CONVENTIONAL RADIOTHERAPY (200 kV) AND COBALT THERAPY IN THE TREATMENT OF CANCER OF THE LARYNX. Baclesse, F. (Foundation Curie, Paris, American Hospital, Paris). Clin. Radiol., 18: 292-300(July 1967).

A comparison is given of the results obtained by treating laryngeal cancer with 200 kV x rays and Cobalt therapy, at the Foundation Curie and the American Hospital, Paris. Three hundred and twenty four patients received treatment by conventional radiotherapy; of these, 36% survived 5 years. Although only 44 patients have received treatment with Cobalt therapy, and the overall 5 year results are similar, the author believes that the outlook in T2 and T3 cases is better with this method of treatment. Reactions with Cobalt therapy are less severe and only one of these patients has required a tracheostomy, 11 months after treatment. (auth)

41446 INCREASED RESISTANCE OF MICE TO X-IRRADIATION AFTER THE INJECTION OF BEE VENOM. Shipman, W. H.; Cole, L. J. (Naval Radiological Defense Lab., San Francisco). Nature (London), 215: 311-12(July 15, 1967).

It was thought possible that because of the chemical composition and pharmacological effects of the known components of bee venom it might be of value as a radioprotective agent. The venom might produce physiological "stress" and thereby elicit a neuroendocrine response (pituitary-adrenal stimulation), so-called adaptation syndrome, which would increase radiation resistance. The venom is a complex mixture of enzymes, toxins, and unidentified substances, the neurotoxic polypeptides mellitin and apamine constituting the largest fraction. Experimental studies with mice are described. In one group of tests the mice received 1.24 μg venom/g body weight, delivered intraperitoneally 24 hr before exposure to an x-ray dose of 800 R. At the end of a 30 day period of observation 64% of the mice were alive, compared with 22% of a control group. In another group of tests either subcutaneous or intraperitoneal injection was used, followed by exposure to 825 R. After 30 days 80% of the subcutaneously injected mice were alive, but only 20% of the intraperitoneal, and none of the controls. The venom dosages in these cases were 5.6 μg/g body weight subcutaneous, or 1.1 μg/g intraperitoneal. For mice injected subcutaneously with 4.3 μg/g or 5 μg/g one day before exposure to 850 R, the 30-day survival was 70% (controls 0%). At these dosages, however, the venom was ineffective when administered 30 min before irradiation, or immediately after exposure. The fact that the venom gives protection when administered 24 hr before exposure places it in a different category from AET, cysteine, and related compounds. Attempts were made to identify the radioprotective constituents of the venom. Mellitin was isolated and tests made on mice, with 57% survival (subcutaneous injection at 5.4 μg/g; dose 850 R). Possible mechanisms are discussed. (UK)

41447 EXPERIMENTAL STUDIES ON THE RADIOPROTECTIVE ACTION OF TRIHYDROXYETHYL-RUTOSIDE (VENORUTON P_4). Zukerman, Zvi (Univ., Basel). Dermatologica, 134: 177-86(1967). (In German).

The action of this bioflavinoid, which has protective activity on capillaries, was tested for radioprotective effects in guinea pigs and rabbits. It was hypothesized that since injury to blood vessels is a major factor in radiation injury, this compound might ameliorate some of the effects of radiation. Guinea pigs were given 250 to 5000 mg/Kg doses of Venoruton followed by doses of 800 to 1200 R of 55-KV x rays to the skin. Epilation was assessed 10 to 14 days later. Rabbits were exposed to local doses of x rays (2500 to 20,000 R) and 10 min later injected with 1 to 2 g/Kg doses of the drug, after which permeability was tested in skin capillaries with trypan blue. Experiments on the prophylactic effect of Venoruton against lesions caused by radiation gave negative results with the mouse epilation test. Demonstration of protection against early radiation effects by the trypan blue reaction was possible only with large doses of Venoruton. Similarly, a mildly favorable influence on the recovery of radioinjured skin of rabbits was obtained only with large doses and prolonged treatment. The effect of Venoruton on vascular permeability did not seem to be related to the mechanism of protection against radiation. (BBB)

41448 VARIATIONS IN ENZYMES IN PLASMA OF RATS AFTER INJECTION OF A RADIOPROTECTIVE DOSE OF CYSTEAMINE. Plomteux, G.; Beaumariage, M. L.; Bacq, Z. M.; Heusghem, C. (Univ., Liege). Biochem. Pharmacol., 16: 1601-7(Aug. 1967). (In French).

Various intracellular enzymes (TGO, LDH, MDH, GIDH, β/glycuronidase) were titrated in the plasma of adult rats after an intraperitoneal injection of 100 mg/kg of cysteamine (base). A large increase in the level of these enzymes is observed after 25 min; the maximum is reached in 2 hr; normal levels are observed after 6 hr. Regular variations in the LDH isoenzymes were not seen, but in a number of rats a doubling of the fifth fraction was observed in late (4 or 6 hr) plasma samples. These facts show that a large radioprotective dose of cysteamine induced an intense and rapid, but easily reversible, cellular shock. They are compatible with the observations of various authors using electron microscopy. (auth)

41449 TRITIUM UPTAKE, HALF-LIVES, AND RADIATION DOSES IN TISSUES OF CANCER PATIENTS TREATED WITH TRITIATED 2-METHYL-1:4-NAPHTHAQUINOL DIPHOSPHATE. Chipperfield, Barbara (Cambridge Univ., Eng. Addenbrooke's Hospital, Cambridge, Eng.). Int. J. Cancer, 2: 381-95(July 15, 1967).

Comparisons of the uptake into tumour biopsies 30 min after intravenous or intraarterial injections showed that tumours of gastrointestinal origin took up significantly greater amounts of the tritated drugs than did any other group of tumours, and with other types of tumours some individual biopsies showed very high tumour specific activities after intraarterial injections. The tritium in the tumour disappeared by two exponential decay processes, one with a half-life of 1.35 days and the other with a half-life of 14.4 days. The ratio of the concentration of the long-lived component to that of the short-lived component was 0.33. Tritium estimations on normal tissues taken at autopsy from patients who received only one injection of the tritiated drug showed that the biological half-life in normal tissues ranged from 5.7 days (heart) to 34.5 days (long-lived component in brain). The initial specific activity in μc/g for each c/kg injected ranged from 71 (long-lived component in brain) to 505 (kidney). After a single injection of 1cc of the drug per kg body weight, the greatest doses of radiation were received by the kidney (1,600 R), testis (1,300 R), liver (1,050 R), and brain (990 R). The lowest doses were received by skeletal muscle (395 R) and bone marrow (604 R). The radiation dose in the tumour depends on the initial concentration and the half-life in the tumour. Initial tumour concentrations of 5 to 8 mc/g wet tissue should give radiation doses in the therapeutic range after a single injection. (auth)

41450 TRANSPLANTABLE MOUSE NEOPLASM CONTROL BY NEUTRON CAPTURE THERAPY. Farr, L. E.; Konikowski, T. (Univ. of Texas, Houston). Nature (London), 215: 550-2 (July 29, 1967).

A procedure has been evolved which can be added to the few effective treatments for established invasive transplantable neoplasms in animals. In this communication, studies are reported to determine the thermal neutron flux which must be incident on the skin over solid neoplasms, 8 to 17 mm in diameter, to result in permanent regression, after giving sodium pentaborate intravenously in dose equivalent to 35 μg/g body weight of ^{10}B. Glucose was employed to minimize borate toxicity. Only a single treatment was required by this procedure. The principle is to generate alpha particles and lithium atom fragments from the ^{10}B. For a given neutron flux, decreasing effects were observed as the neoplasm diameter increased; this is in agreement with the expected attenuation of thermal neutron clouds in tissue. Histological study showed no neoplastic cells at neoplasm sites after successful treatment. Under the conditions of the experimental work the normal muscle and vascular tissue at the site of the regressed neoplasm appeared unaffected by the treatment. Longevity of the successfully treated animals was not significantly altered from normal expectancy. (UK)

41451 DAMAGE TO DEOXYRIBOSE MOLECULES AND TO U-GENE REACTIVATION IN UV-IRRADIATED 5-BROMOURACIL-DNA OF PHAGE T4 Bo^r AS INFLUENCED BY CYSTEAMINE. Hotz, G.; Reuschl, H. (Kernforschungszentrum, Karlsruhe, Ger.). Mol. Gen. Genet., 99: 5-11(1967).

Experimental evidence for the destruction of DNA-deoxyribose by uv irradiation in T4 Bo^r bacteriphage that had incorporated 5-bromouracil (BU) into its DNA is given. The damage to the deoxyribose component and the sensitizing effect of the base analog, BU, observed in dose-survival curves of phage, were eliminated by irradiation in the presence of M/100 cysteamine: i.e., μ-gene reactivation was nearly normal. A working hypothesis is put forward to explain the blocking effect of BU on enzymes that reactivate DNA-lesions and to explain the mechanism by which cysteamine prevents this block. (B.H.S.)

41452 STUDIES OF CEREBROSPINAL FLUID DYNAMICS WITH INTRATHECALLY ADMINISTERED RADIOIODINATED HUMAN SERUM ALBUMIN (^{131}IHSA). Tator, C. H.; Fleming, J. F. R.; Sheppard, R. H.; Turner, V. M. (Toronto Western Hospital). Can. Med. Ass. J., 97: 493-503(Sept. 2, 1967).

Twenty-two patients received an intrathecal injection of radioiodinated human serum albumin (^{131}IHSA). The distribution and flow of the tracer in the intracranial subarachnoid space was followed by serial scintillation scanning. In normal cases, a consistent pattern of flow of the tracer through the basal cisterns and subarachnoid space over the cerebral hemispheres was found. Certain intracranial tumours caused deflection or obliteration of adjacent subarachnoid pathways. In patients with previous cerebral trauma, focal accumulations of radioactivity were detected in damaged portions of the cerebral hemispheres. The communication of certain cystic lesions with the subarachnoid space could be determined with this technique. The diagnosis of communicating hydrocephalus and the site of the subarachnoid block could be determined and thus, cases of communicating hydrocephalus could be differentiated from those of cerebral atrophy with hydrocephalus-ex-vacuo. In the former, there was obstruction to the flow of ^{131}IHSA, while in the latter the subarachnoid pathways were widely patent. (auth)

41453 ISOLATION OF CYTOMEGALOVIRUS FROM PERIPHERAL BLOOD. Harnden, D. G.; Elsdale, T. R.; Young, D. E.; Ross, A. (Medical Research Council, Edinburgh, Scotland). Blood, 30: 120-5(July 1967).

Cytomegalovirus (CMV) was isolated on two separate occasions from the washed leukocyte fraction of the peripheral blood of an 8-yr-old boy with acute lymphatic leukemia. He was treated previous to the first blood sample with drugs and x irradiation. He died one day after the second blood sample was taken. The mother had an x-ray pelvimetry during the pregnancy, and the child was delivered by Caesarian Section. An older brother is alive and well, but a younger sister has neuroblastoma. The child showed no other evidence of CMV infection. The relation between CMV infection and leukemia is discussed. (M.M.B.)

41454 PRODUCTION OF GRANULOCYTIC PROGENY BY TRANSPLANTED BONE MARROW IN IRRADIATED MICE. Hellman, Samuel; Grate, Helen E. (Yale Univ., New Haven). Blood, 30: 103-11(July 1967).

The production of granulocytic progeny by transplanted mouse bone marrow is described. Normal marrow was injected into lethally x-irradiated recipients. Seven to 9 days was allowed for stem cells in the marrow to proliferate and differentiate. The granulocytic response to a bacterial endotoxin was then measured. This response bore a linear relationship with the number of bone marrow cells injected and could be used as an assay of granulocytic progenitor cells in bone marrow. (auth)

41455 MEASUREMENT TECHNIQUES FOR THE CLINICAL APPLICATION OF RADIOISOTOPES. Tothill, P. Medical Monograph No. 2. Amersham, Eng., Radiochemical Center (UKAEA), 1966. 28p.

This is one of a series of monographs discussing the clinical applications of radioisotopes, published by the UKAEA Radiochemical Centre. Headings include: Types of radiation; statistics; correction for lost counts; methods of detection; choice of counting method; multiple isotope experiments; practical considerations; electronic equipment; setting-up procedures. (UK)

41456 BIO-ASSAY AND BODY COUNTER RESULTS FOR THE FIRST 2 YEARS FOLLOWING AN ACUTE PLUTONIUM EXPOSURE. Lagerquist, C. R.; Putzier, E. A.; Piltingsrud, C. W. (Dow Chemical Co., Golden, Colo.). Contract AT(29-1)-1106. Health Phys., 13: 965-72(Sept. 1967).

An accident occurred at the Rocky Flats plant on 12 June 1964, in which an employee was exposed to plutonium. The accident resulted from an explosive reaction between hot plutonium metal and carbon tetrachloride. Debris from the explosion struck the employee in the left hand, causing severe injury to the thumb and second finger. There were about 144 μCi of plutonium embedded in the wounds. Surgery has been performed on the hand 4 times since the accident. After the fourth surgical procedure $^{9}/_{10}$ μCi of plutonium remained. Treatments by DTPA (diethylenetriaminepenta-acetic acid) were given to the employee in various amounts and schedules since the accident. These treatments were largely responsible for the elimination of 8 μCi of plutonium via the urine. In vivo measurements of plutonium in the hand, lung, liver, and skull were made periodically, using the Rocky Flats body counter. (auth) (UK)

41457 NEW TRACER FOR LIVER SCANNING. Maass, R.; Alvarez, J.; Arriaga, C. (Comision Nacional de Energia Nuclear, Mexico City. Centro Hospitalario, Mexico City). Int. J. Appl. Radiat. Isotop., 18: 653-4(Sept. 1967).

A new colloidal carrier is described for liver scanning. This substance can be tagged with a number of different radioisotopes, such as Tc-99m, In-133m, Fe-59, and Cr-51. Binding efficiency was about 90%. The colloid is actively taken up by the liver in about 20 min. Preparation time for this colloid is 10 min., providing reagents and glassware are ready for use. Toxicity studies have shown no detectable signs or symptoms of intolerance. Washout of colloid by liver R. E. shows a biological half-life of 8 days. The colloid is based on stannous hydroxide/gelatin. (auth)

41458 THE AIR-BORNE DISSEMINATION OF VIABLE TUMOR BY HIGH-ENERGY NEODYMIUM LASER. Hoye, Robert C.; Ketcham, Alfred B.; Riggle, Grant C. (National Cancer Inst., Bethesda, Md.). Life Sci., 6: 119-25(Jan. 15, 1967).

The effect on tumor tissue of the pressure phenomenon or propulsive forces associated with the impact of a high-energy neodymium laser beam was studied. The amount of propulsive force associated with the laser-tissue interaction was found to be dependent upon the type of tumor and its surface covering. The energy necessary to destroy a small subcutaneous melanoma implant was considerably less if the overlying skin was surgically opened and the tumor exposed directly to the laser beam. There was a considerable amount of splatter of tumor tissue in all directions in the air and as far away as six to eight ft from the site of impact of the laser beam on the primary tumor. Growth of the larger melanoma fragments, locally disseminated by the force associated with the laser impact of the tumors, occurred in recipient mice between 12 and 57 days post-treatment. The visible growth rate, gross appearance, and histological characteristics of these secondary tumors were similar to the parent tumor. The splattered, air-borne tissue appeared to be partially coagulated, presumably by the high temperature of the plume associated with the laser impact. This factor, plus the difficulty in recovering the smaller fragments of disseminated tumor in some experiments, probably accounts for the lack of growth in the recipient animals of smaller fragments. The occurrence of disseminated tumor fragments, which upon gross examination appeared viable following laser treatment, was not limited to the S-91 melanoma. It was also observed following laser treatment of a mammary adenocarcinoma in C_3H/HeN mice, the V × 2 carcinoma in rabbit liver, and during treatment of chemically induced hepatomas in monkeys. (BBB)

41459 THE RESULTS OF COMPLEX TREATMENT OF PATIENTS WITH THE THYROID CANCER. Ivanitskaya, V. I.; Shantyr', V. I. (Research Inst. of Radiology, Kharkov). Vop. Onkol., 13: No. 7, 69-74(1967). (In Russian).

The effectiveness of four different methods used in treating cancer of the thyroid gland in 264 patients was evaluated over a 15 year period (1948 to 1964). Four methods of treatment were used: complex (radical surgery, the use of ^{131}I, and external irradiation in 71 cases; operative-radiation ^{131}I and surgery cases); 15 combined irradiation (^{131}I and x-ray therapy) in 59 cases and external irradiation in 59 patients. Best results were obtained in complex treatment (65.2 percent recovery). In the operative-radiation method, recovery was noted in 47.5 percent; in combined irradiation, 9.3 percent. In external irradiation recovery was noted in 3.4 percent. The extensive use of radical surgery increased the number of cured patients 28.9 percent, whereas the application of ^{131}I improved the efficacy of treatment in thyroid cancer 35.2 percent. (auth)

41460 RECTOVAGINAL FISTULAS DUE TO RADIATION. Slot, E.; Graham, J. (State Univ. of New York, Buffalo). Neoplasma, 14: 313-27(1967).

Rectovaginal fistulas due to radiation usually occur within the first two years after radiotherapy but may be seen as late as 24 years. A generous biopsy will distinguish them from fistulas due to cancer. They are treated by transverse colostomy, waiting for the necrosis to subside and then repair utilizing a nonirradiated, vascular tissue such as gracilis muscle to bolster the suture line. In a series of 25 cases, 20 were repaired successfully with two operative deaths. (auth)

41461 INTENSIVE COMBINATION CHEMOTHERAPY AND X-IRRADIATION IN HODGKIN'S DISEASE. Moxley III, John H.; De Vita, Vincent T.; Brace, Kirkland; Frei III, Emil (National Cancer Inst., Bethesda, Md.). Cancer Res., 27: 1258-63(July 1967).

A pilot study was begun in 1963 to test the feasibility of using in the treatment of Hodgkin's disease, a combination of cyclophosphamide, vincristine, methotrexate, and prednisone in full doses followed by radiotherapy where indicated. It was found that this form of therapy could be used without a prohibitive cost in toxicity. It appears that the incidence of complete remissions can be increased over that obtained with a single agent. Radiotherapy was tolerated after intensive chemotherapy, and further intensive chemotherapy was possible following high dose but limited field radiation. As expected, toxicity was increased when both modalities of therapy were employed. The duration of complete unmaintained remission in those patients with advanced disease is provocative even though the group is small. It is our feeling that these results invite further investigation of the use of effective agents in combination. (auth)

41462 SCINTIGRAPHIC INVESTIGATION OF RENAL INJURIES. Braedel, H. U.; Breuer, E. (Klinik fuer Roentgen- und Nuklearmedizin, Ludwigshafen, Ger.). Fortschr. Geb. Roentgenstr. Nucklearmed., 107: 213-23(1967). (In German).

A report is given of scintigraphic investigations with ^{197}Hg and ^{203}Hg on eight patients with renal injuries. Good agreement between urogram and scintigram was obtained whereby the information from the scintigram is more accurate and goes farther. Additional results obtained from scintigrams taken with reduced sensitivity are discussed. Significant defects in the renal scan lead also to positive findings in the presentation of the vascular system. Scintigraphic checking of the healing process is possible and recommended. (auth)

41463 CHEMICAL PROTECTION AGAINST X-RADIATION IN THE GUINEA-PIG. I. RADIOPROTECTIVE ACTION OF RNA AND ATP. Wagner, Richard; Silverman, Evelyn C. (New England Medical Center Hospitals, Boston. Tufts Univ., Boston). Int. J. Radiat. Biol., 12: 101-12(1967).

The protective effect of RNA and ATP against x-radiation injury was demonstrated in guinea pigs. The survival rates of the protected animals considerably exceeded those of the controls. Leu-

cocyte counts and haematocrits returned to normal values in the protected animals, three weeks following irradiation. ATP concentration in the blood of the controls showed a considerable decrease a few hours following irradiation. In the fatal cases it was observed to drop as much as 5.6 to 6.7 mg percent. In the ATP-protected animals the initial drop was the same as in the controls. After 7 days ATP concentration returned to normal levels, in many instances with a tendency to overshooting reactions. In contrast to ATP protection the response to RNA was different; the initial drop was absent, or ATP concentration even slightly increased. (auth)

41464 THE PROTECTIVE EFFECTS OF SOME NARCOTIC SUBSTANCES AGAINST X IRRADIATION IN AQUATIC ANIMALS. I. EFFECTS OF CHLOROBUTANOL IN LARVAE OF RHACOPHORUS ARBOREUS. Tanaka, Norimoto (Kyoto Univ.). Nippon Igaku Hoshasen Gakkai Zasshi, 26: 1001-11(Nov. 1966).

The effects of treatment with 5 percent chlorobutanol prior to and during irradiation on the survival response and body weight were studied in larvae of Rhacophorus arboreus. It is known that chlorobutanol solutions have an anesthetic action on aquatic animals. Five percent chlorobutanol-treated animals were protected against radiation, as indicated by a highly-significant increase in the number of surviving animals and by a slight increase in the body weight as compared with the irradiated-only controls (1800 R). (auth) (NSA of Japan)

41465 DISTANCE RADIUM THERAPY OF ADENOMA OF THE HYPOPHYSIS. Ruderman, A. I.; Slavin, L. G. Probl. Endokrinol., 12: No. 3, 42-9(May-June 1967). (In Russian).

The results of x ray therapy of 300 patients suffering from hypophyseal tumors are discussed. In cerebro-hypophyseal diseases, caused by tumor of the hypophysis, radium therapy should be prescribed in accordance to a stage of the tumor process development. Radiation therapy with a focal dose of 2,000 to 3,000 rad is recommended in zero, first, and second stages of adenoma. Surgical treatment is recommended in the third and more advanced stages of the tumor development. In the presence of contraindications to surgical treatment radiation therapy with a focal dose of 6,000 to 7,000 rad is possible. Since the use of high energy radiation in comparison with x ray therapy is usually accompanied by less pronounced general and local reactions, it is expected that the efficacy of radium therapy is to be more effective. Small radiation fields are recommended in any radium therapy. (auth)

41466 THE THYROID GLAND FUNCTION AT REMOTE PERIODS AFTER ^{131}I TREATMENT OF PATIENTS SUFFERING FROM THYROTOXICOSIS. Dubovyi, E. D.; Voronenko, T. V. Probl. Endokrinol., 12: No. 3, 18-22(May-June 1967). (In Russian).

The functional state of the thyroid gland was studied according to radioindication data in 142 patients 2 to 7 years after the completion of ^{131}I therapy. In the majority of patients radioiodine absorption by the thyroid gland 2 to 4 years after ^{131}I therapy corresponded to the clinical effect; in 4 to 7 years there was a correlation between the clinical state and radioindication data in all the treated patients. The functional state of the thyroid gland, determined by ^{131}I absorption was changed for a long time (2 to 7 years) after radioiodine therapy. Mean data of ^{131}I absorption 2 to 7 years after the treatment were independent of the severity of thyrotoxicosis and the character of goiter before the beginning of radioiodine therapy. (auth)

41467 FUNCTIONAL PECULIARITIES OF THROMBOCYTES IN THE PATIENTS WITH POLYCYTHEMIA VERA IN CONNECTION WITH RADIOPHOSPHORUS THERAPY. Matvienko, L. A. Probl. Gematol. Pereliv. Krovi, 12: No. 7, 28-31(July 1967). (In Russian).

Functional properties of thrombocytes were studied in 19 patients suffering from polycythemia vera in connection with the course of the disease and ^{32}P therapy. Thrombocytes in this disease proved to be of inferior quality; also an association was established between the functional disturbances of thrombocytes and the development of complications in the blood coagulation system. A rise of thrombocyte activity was noted directly after the ^{32}P treatment, for 3 to 4 weeks. (auth)

41468 RADIATION THERAPY AND WOUND HEALING DELAY. ANIMALS AND MAN. Powers, W. E.; Ogura, J. H.; Palmer, L. A. (Washington Univ., St. Louis). Radiology, 89: 112-15(July 1967).

In a series of 214 patients operated on after radiotherapy, there was no demonstration of an optimal dose of radiation or time delay between radiation and surgery to permit complete and adequate wound healing with minimum delay. In animals studied to determine the optimal dose and time interval between irradiation and surgery for wound healing to take place, it is noted that fifteen days appears to be an optimum. There is less adequate wound healing and more delay in the earlier and the later periods. (auth)

41469 STUDIES ON OPTIMAL DOSE OF PREOPERATIVE IRRADIATION AND TIME FOR SURGERY IN THE CURE OF A MOUSE LYMPHOSARCOMA. Perez, Carlos A.; Powers, William E. (Washington Univ., St. Louis). Radiology, 89: 116-22 (July 1967).

Studies in normal and immunologically incompetent mice with a lymphosarcoma demonstrated difference in surgical cure rate; a beneficial effect of preoperative x radiation therapy at all dose levels employed in both populations; and an improvement in cure rate related to the increasing radiation doses given. Delay of surgical resection seven days after irradiation resulted in a significant number of unresectable tumors. This was closely related to the dose of preoperative irradiation. Studies on the influence of variation on time delay for surgery after preoperative irradiation indicate that a moderate dose (2,000 to 3,000 rads) and short delay give the best curative results. Interference with wound healing was more frequent with increasing doses of radiation. With doses below 1,000 rads, this was probably related to recurrence. The limited extent of extrapolation from the results of these experiments to clinical practice is pointed out. (auth)

41470 CLINICAL RADIOISOTOPE SCANNING. Wang, Yen. American Lecture Series. Publication Number 664. A Monograph in The Bannerstone Division of American Lectures in Roentgen Diagnosis. Springfield, Ill., Charles C Thomas Publisher, 1967. 253p. $12.50.

Developments in the field of clinical radioisotope scanning are described. Topics discussed include basic concepts of the mechanisms involved, radioactive preparations used as tracers, instruments used for scintillation scanning, specific clinical applications in the various organs of the body, descriptions of findings in normal tissues, the localization of neoplasms, and a comparison of radioisotope scanning to other clinical tests. Techniques are described for scanning of the thyroid, brain, lungs, cardiovascular system, liver, spleen, pancreas, kidneys, bones, placenta, parathyroid, and myocardium. (270 references) (C.H.)

41471 RADIOISOTOPES IN LOCALIZATION DIAGNOSTICS. 4th Annual Meeting of the Society for Nuclear Medicine in Heidelberg, October 6-8, 1966. Hoffmann, G.; Scheer, K. E. (eds.). Nucl.-Med., Suppl. 6, 1-571(1967). (In German). (CONF-661053).

Eighty papers discuss various aspects of the use of radioisotopes for clinical scanning. Topics discussed include basic concepts, radioactive preparations used as tracers, the performance of scanning instruments, the localization of neoplasms, and the use of radioisotope scanning for the diagnosis of various disease conditions. A list of references is included for each paper. (C.H.)

41472 TUMORS OF THE KIDNEY FOLLOWING RETROGRADE PYELOGRAPHY WITH COLLOIDAL THORIUM DIOXIDE. Wenz, Werner (Univ., Heidelberg). 11p. (CONF-660422-6). DTIE.

From Conference on Distribution, Retention, and Late Effects of Thorium Dioxide, New York.

Up to the present 25 malignant thorotrast tumors of the kidney have been described following retrograde pyelography. The major causes for the retention of the contrast medium in the kidneys are: reflux, hydronephrosis and out-flow obstruction. The relatively long latent period of 27 years is a result of the very small amount of retained thorotrast. The malignant tumors are found practically exclusively in kidneys which have given rise to ill defined renal complaints due to chronic inflamatory changes and granulomas. There is a quantitative relation between tumor incidence, latent period and dosage of thorotrast. (auth)

Radiation Effects on Animals

Refer also to abstracts 41336, 41411, and 41460.

41473 (AED-C-04-29) BIBLIOGRAPHIEN ZUR KERNFORSCHUNG UND KERNTECHNIK. SEKTION 04. STRAHLENWIRKUNG AUF LEBENDES GEWEBE UND ORGANISMEN. (Bibliographies in Nuclear Science and Technology. Section 04. Radiation Effects on Living Tissues and Organisms). Stahlhofen, W. (comp.) (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). June 1967. 174p. (In German and English). Dep.

Approximately 500 references are presented to journal and report literature on the effects of radiation on living tissues and organisms. (C.H.)

41474 (NP-16848) LASER HAZARDS BIBLIOGRAPHY, APRIL 1967. (Army Environmental Hygiene Agency, Edgewood Arsenal, Md.). 22p.

Two-hundred references are presented to literature on the biological effects of lasers and equipment and procedures for protection against laser radiation. (C.H.)

41475 (NP-16851) PROBLEM OF TUBERCULOSIS IN THE POSTATTACK ENVIRONMENT. Mitchell, H. H. (RAND Corp., Santa Monica, Calif.). June 1967. 78p. (RM-5362-PR).

As late as 1900 tuberculosis was the first cause of death in the United States but by 1960 had receded to sixteenth. It is still, however, a relatively important public health problem, and even with current rates of decline continuing, eradication will not have been accomplished by the year 2000. Thus any postattack population must be expected to be well seeded with individuals infected with tuberculosis. The conditions that have been shown to be correlated with high tuberculosis rates in the past (malnutrition, poor housing, overcrowding, etc.) are the ones we might well expect to prevail in the postattack environment. Also such general stresses as war, concentration-camp living, etc., that raise pre-existing tuberculosis rates considerably, are relevant to the postattack problem. Several important questions of concern to an estimate of the postattack tuberculosis problem remain unresolved. These are: The effect of cumulative fallout radiation dose on host resistance; The possibility of increased susceptibility of the U. S. population because of lessened immunity as tuberculosis is increasingly brought under control; The effect of postattack environmental changes on the incidence of explosive localized epidemics — rare now for reasons unknown; The expected incidence of clinical cases among the infected population has been estimated to range between 6 and 50 percent by competent authorities. Where the true value lies is not known. The modern chemotherapeutic and chemoprophylactic agents as well as BCG vaccine, if made available in the postattack environment, make tuberculosis control a reasonable goal if accompanied by an adequate public health program. Planning is essential if this goal is to be attained. In the absence of active control, tuberculosis could well be the most serious infectious disease problem in the postattack environment. The infectious agent will undoubtedly be widely disseminated in the survivors of a nuclear attack, and almost all the changes brought about in the physical and socio-economic environment can be expected to increase the tuberculosis threat. (auth)

41476 (ORNL-P-3212) RADIATION EFFECTS IN THE SORICIDAE, CRICETIDAE, AND MURIDAE. Dunaway, P. B.; Lewis, L. L.; Story, J. D.; Payne, J. A.; Inglis, J. M. (Oak Ridge National Lab., Tenn.). [1967]. Contract W-7405-eng-26. 27p. (CONF-670503-23). Dep. CFSTI.

From 2nd National Symposium on Radioecology, Ann Arbor, Mich.

Effects of acute, ^{60}Co gamma irradiation under controlled conditions in the laboratory were compared in six species of rodents in the Cricetidae, two species in the Muridae, and two species of shrews in the Soricidae. Estimates of LD_{50-30} for ten species ranged from 525 to 1069 rads. The most radioresistant species (two species of Peromyscus) and the most radiosensitive species (Oryzomys palustris) were cricetids. Average survival times of decedents at highest radiation doses (1560 to 2060 rads) were longer among cricetids (5.6 to 8.1 days) than in murids (4.4 to 5.1 days) or soricids (3.5 to 4.3 days), and interspecific variation was manifested within families. Survival times were longer and LD_{50} estimates were greater in RF-strain, female Mus musculus caged alone than in females caged in groups of five or in males caged either singly or in groups. At high doses, weight losses were rapid and severe in all species, but at lower doses considerable interspecific differences were seen in time of onset and magnitude of weight changes. Other symptoms of radiation damage were conjunctivitis, ataxia, diarrhea, passiveness, cessation of feeding, aggressiveness, and pelage graying. (auth)

41477 (USNRDL-TR-67-79) CLONAL REPOPULATION IN RETICULAR TISSUES OF X-IRRADIATED MICE: EFFECT OF DOSE AND OF LIMB-SHIELDING. Nowell, P. C.; Cole, L. J. (Naval Radiological Defense Lab., San Francisco, Calif.). July 11, 1967. 25p. CFSTI.

Chromosome studies in irradiated mice have indicated that following high sublethal whole-body exposure, regeneration of the reticular tissues occurs in a clonal fashion. With increasing doses, from 100 to 700 rads, these organs appeared to be repopulated from fewer and fewer surviving stem cells. In a few instances at the highest dose, the progeny of the same cell apparently differentiated to marrow cells at one site and to lymphoid cells in others, suggestive evidence of a totipotent hematopoietic stem cell in the adult mouse. Chromosome studies in mice receiving 900 rads with one limb shielded have indicated repopulation of the thymus and other reticular tissues by undamaged cells from the shielded marrow. Such marrow-derived cells, perhaps by restoring immunological competence or by nonimmunological contact inhibition, could account for the known effect of limb shielding in reducing the incidence of radiation-induced thymic lymphomas. (auth)

41478 REGENERATION OF THE HEPATIC PARENCHYMA IN RATS IN ^{144}Ce AFFECTION. Romanova, L. F. (Inst. of Biology of Dept. of Public Health, Moscow). Arkh. Patol., 29: No. 7, 52-7(1967). (In Russian).

A study of hepatic parenchyma response to continuous irradiation with β-particles and γ-quants of hepatotropic ^{144}Ce isotope was carried out on 19 albino rats of the Wistar line, which died at the periods 1 to 1.5, 3 to 3.5, and 8 to 8.5 months, as well as those killed 10 months after the beginning of the experiment; 17 control rats were sacrificed in accordance to the periods of death of the experimental animals. Chloride of ^{144}Ce was administered to rats intraperitoneally in a dose of 1 μCi per g of body weight. A study was made of the morphology and kariology of the liver, number of mitoses and amitoses; binuclear cells were counted. During the first experimental month there was a circulatory disturbance, an acutest fatty degeneration and death of a considerable number of hepatic cells, giving a picture of yellow atrophy of the liver. Cirrhosis of the liver developed in 9 of 19 cases by the 3rd to 8th month; in 5 cases adenomatous proliferations from the hepatic epithelium were observed; in 6 such proliferations originated from the epithelium of false bile ducts. The following is characteristic of the irradiated liver: appearance of numerous hepatic cells with very large (from 11 to 23 μ) and very small (<5 μ) nuclei, a rise in the number of binuclear cells and of amitoses. The mitotic activity level increased only by the 10th month from the beginning of the experiment. The extent of these processes in conditions of the given experiment was much greater than in physiological regeneration. (auth)

41479 RADIOACTIVE PHOSPHORUS IN THE TREATMENT OF POLYCYTHAEMIA. A REVIEW OF TEN YEARS' EXPERIENCE. Arthur, Keith (United Birmingham Hospitals, Eng.). Clin. Radiol., 18: 287-91(July 1967).

One hundred and fifteen patients treated for polycythemia vera by radioactive phosphorus are studied. The results are compared with those described by Perkins, Israels and Wilkinson (1964) for patients treated by cytotoxic drugs alone. Overall results are found to be very similar, the loss of patients treated by the isotope method through acute leukemia being balanced by a greater proportion of patients in the non-irradiated group dying of uncontrolled polycythemia and its complications. A detailed study of irradiated patients with polycythemia who developed acute leukemia is undertaken in an attempt to establish common factors. A two-fold incidence over the expected number of malignant tumors is noted in the series. (auth)

41480 THE EFFECT OF WHOLE-BODY X-IRRADIATION ON MUCOSAL IODIDE TRANSFER BY THE SMALL INTESTINE OF THE RAT IN VITRO. Acland, J. D. (Univ. of Sheffield, Eng.). Int. J. Radiat. Biol., 12: 177-82(1967).

Measurements of iodide transfer by sacs of everted intestine of the rat were made at 4 hours and 72 hours after 450 R of whole-body x irradiation to determine whether iodide transfer was carried out by cells with a similar radiosensitivity to that of cells responsible for glucose transfer. Dietary regimes were varied before and after irradiation; a comparison was made between the results obtained after irradiation with those obtained after fasting. It was observed that whole-body irradiation had no effect on mucosal iodide transfer at 4 hours but reduced it at 72 hours. Fasting for 24 hours caused a reduction in mucosal iodide transfer of the same order as that observed 72 hours after irradiation. It was concluded that iodide transfer was carried out by mature cells with the same radiosensitivity as that shown by the cells that carry out glucose transfer and not by the stem cells. (B.H.S.)

41481 THORIUM DIOXIDE MYELOPATHY. Dale, Allan J. D.; Love, J. Grafton (Mayo Clinic, Rochester, Minn.). J. Amer. Med. Ass., 199: 606-9(Feb. 27, 1967).

Chronic arachnoiditis and myelopathy developed in 3 patients after myelography with ThO_2. Progressive involvement of the cauda equina, spinal cord, and brain stem was observed. The interval between myelography with ThO_2 and the onset of symptoms of intraspinal disease was long (14 yr) in 2 of these patients; it was very brief (9 months) in the third patient, who had a prominent meningeal reaction immediately after myelography. Signs and symptoms of involvement of the cauda equina were the first to appear in all 3 patients, manifested by bladder dysfunction, muscle weakness, and impaired sensation in the lower limbs and the buttocks, and loss of potentia in the male patients. Severe leg pains were present in 2 of the patients. In 2 patients, ascending involve-

ment of the spinal cord and brain stem also gradually developed. In case 1 there was unilateral nerve deafness together with bulbar and pseudobulbar palsy, and increasingly severe weakness of both upper limbs. In case 3, unilateral nerve deafness, dysphagia, bilateral facial weakness, unilateral ophthalmoplegia, and nystagmus were also present. Both of these patients had roentgenologic evidence of intracranial deposition of contrast medium. Arachnoiditis involving the spinal meninges and associated with shrinkage of the spinal cord was proved surgically and histologically in all 3 patients. Meningeal fibrosis was prominent, and deposition of small granules of amorphous material was noted. The chronic myelopathy and arachnoiditis seen in these patients could only be treated symptomatically with measures for relief of pain, care of the bladder, assistance with walking in the early stages, and avoidance of decubitus ulcers as the paraplegia progresses. (BBB)

41482 PLASMA TORCH REACTIONS IN THE SKIN. Goldman, Leon; Solomon, Herman Jr.; Rockwell, R. J. Jr.; Meyer, Robert; Otten, Robert; Epstein, Robert (Univ. of Cincinnati). J. Invest. Dermatol., 48: 478-80(May 1967).

Hazards associated with applications of plasma in research and technological applications are reviewed and experiments reported on the skin response to exposure to a plasma torch, employing He and Ar at temperatures up to 20,000°F. Occupational hazards of the plasma torch include such factors as visible radiation, uv, and, perhaps, Grenz rays; noise and dust hazards, especially in certain commercial operations; and the formation of oxides of nitrogen and oxygen in the air. The plasma torch produced a nonspecific coagulation necrosis of animal skin and freshly excised tissue of man. These changes were similar to the coagulation necrosis induced by heat burns, high-frequency electrical currents, and the laser. In the hamster spleen and liver the instrument produced sharp lesions without bleeding of these tissues. There was a gross charring effect of the plasma torch. Vaporization caused not only steam bubbles in the epidermis but also separation of collagen fibers in the dermis. These forms of coagulation necrosis reactions were nonspecific. In the different species of animals used, the reactions varied quantitatively but not qualitatively. The pilosebaceous unit of pig skin showed some resistance to the passage of the plasma torch beam. In general, microscopic sections showed that the plasma torch reaction was much deeper in tissues than had been suspected from the gross clinical appearance. In superficial lesions from the plasma torch in hamsters, the burns healed. No tissue reactions suggestive of radiation changes were found in early or late plasma-torch lesions after several months. (BBB)

41483 COMPLEMENTARY NUCLEAR HEMATOLOGIC EXAMINATION IN RATS AFTER WHOLE-BODY IRRADIATION. Szirmai, E. (Technische Hochschule, Stuttgart); Celander, D. R. pp 1086-90 of Proc. 10th Congr. Europ. Soc. Haematol., Part II, Strasbourg, 1965. Basel, Karger, 1967. (In French).

Blood clotting parameters were studied in rats exposed to 1200 R, whole-body doses of x rays. Tests were conducted 9 to 80 hr postirradiation. No differences were noted in coagulation time, or blood levels of heparin, prothrombin, and factors V and VII on the first two days. By the 3rd day coagulation time was shortened, heparin was diminished, and increases were noted in prothrombin and factors V and VII. At 72 hr postirradiation the increase in prothrombin was 150% and at 80 hr, 210%. The increase in factor V was 170% and that of factor VII 140%. Some implications of these experimental results to problems in radiotherapy involving blood coagulation changes are discussed. Necrosis of tissue caused by irradiation may release products active in blood clotting processes. (BBB)

41484 ADDITIONAL NUCLEAR HEMATOLOGY EXPERIMENTS AFTER TOTAL IRRADIATION. Szirmai, Endre (Technische Hochschule, Stuttgart); Celander, David Robert. Acta Med. Okayama, 20: 229-33(1966). (In French).

Male and female rats were irradiated with a 1200 R dose of x rays. Hematologic and clotting tests were performed on both irradiated and control rats at varying intervals, 9 to 56 hr, postirradiation for each group. Irradiated rats showed no important differences in blood coagulation parameters from control rats until the third day (72 hr). Changes were greatest right before death (3 to 5 days after irradiation). Coagulation time decreased, on the basis of both thrombin time and for thrombin time with toluidine blue; i.e., the amount of heparin (antithrombin comparable to heparin) liberated was diminished. Clotting factors V and VII, and especially prothrombin, showed a large increase in concentration. It was concluded that the necrosis of tissues after irradiation liberates kinases and other activators in blood circulation, thus producing tissue anoxia. Other experiments in progress are discussed. (BBB)

41485 ELECTRON MICROSCOPE STUDIES OF THE EFFECT OF RADIATION ON THE FETAL PANCREAS. Pipan, Nada (Univ. of Ljubljana, Yugoslavia). Protoplasma, 56: 315-35(1963). (In German).

Female mice with 11-, 12-, 14-, or 15-day-old embryos were given doses of 900, 1200, 1350, 1800, or 2000 R of x irradiation, with the abdominal area shielded with Pb plates. Two or 3 days after irradiation the pancreas was removed from the embryos and studied with the electron microscope. Differentiation appeared to be accelerated in cells only slightly irradiated. The endoplasmic reticulum developed faster and the prozymogen granules appeared sooner and in greater amounts than in untreated control animals. The abnormal division or lack of the prozymogen granules observed in severely damaged cells was ascribed to destruction of the endoplasmic reticulum. In relatively young cells, 11 or 12 days old, ruptured cell membranes appeared 2 or 3 days after irradiation. The cytoplasm became vacuolated and encapsulated, with degenerating mitochondria. Irradiated pancreas of 14- or 15-day-old embryos were more radioresistant, but similar effects were observed. The cells became greatly swollen, and cristae appeared on the mitochondria, while the lamellar system of the ergastoplasm was broken up into numerous vesicles. The prozymogen granules were also damaged after irradiation, but the cytoplasm was not vacuolated or encapsulated. The external membranes of the relatively more differentiated, older cells were also more resistant to the disruptive effects of irradiation. (BBB)

41486 THE STATUS OF THE LYMPHATIC TISSUES UPON IRRADIATION WITH THE ISOTOPE ^{60}Co. Kley, W.; Bonse, G.; Dohm, G. Arch. Ohren, Nasen- Kehlkopfheilk, 178: 342-50(1961). (In German).

Presurgical irradiation given approximately six weeks before operation serves four purposes. These comprise diminution of the size of the tumor and improved delimitation, protection against metastases, inactivation of the tumor cells and prevention of their dispersion, and immunization of the operative region against inoculation with metastases. In guinea pigs irradiated with 8100 R of ^{60}Co γ-radiation over a lateral neck region, no blockade of the area lymph vessels in whole or in part was observed either during irradiation or during the subsequent six weeks that intervened before surgery. Presurgical irradiation may affect tumor cells but not normal cells located in the area. The patency of the lymphatic vessels and the phagocytic functions of the reticuloendothelial system concerned were unaffected throughout the irradiation and afterwards. The irradiations appeared to have effects on the lymphatic parenchyma and secondarily on the lymphatic sinus. Differences between the effects of γ irradiation and conventional x irradiation were quantitative, but there were no qualitative differences between the reactions of the lymphatic tissues to the two types of irradiation treatments. (BBB)

41487 DEPRESSION OF RETICULOCYTES BY GAMMA GLOBULIN AFTER SPLENIC X-IRRADIATION. Dalos, B.; Horvath, M. (National Research Inst. for Radiobiology and Radiohygiene, Budapest). Nature (London), 215: 181-2(July 8, 1967).

It appears that local splenic X-irradiation leads to the release of a substance which inhibits mitosis. It has also been found that when blood serum withdrawn from rabbits 3 hours after local splenic X-irradiation is injected intramuscularly into normal healthy rabbits a drop in the number of reticulocytes occurs similar to that occurring after injection of blood plasma from irradiated isolated spleens. Studies are described on the identification of the substance responsible for this drop. It would seem that the factor in the serum responsible is associated with gamma globulin, and it is possible that the same substance is responsible for inhibiting the growth of Jensen sarcoma or fibroblast cultures. It could also well be the same factor which is released from the spleen after X-irradiation. (UK)

41488 EXPERIMENTAL INFESTATION OF THE ALBINO RAT WITH CERCARIAE OF NORMAL AND X-IRRADIATED SCHISTOSOMA BOVIS. Deiana, S.; Arru, E.; Muzzetto, P. (Univ., Sassari, Italy). Boll. Soc. Ital. Biol. Sper., 43: 113-15 (1967). (In Italian).

Attempts were made to develop a vaccine for this schistosome by irradiating the cercariae with 200-kV x rays at doses of 500 to 3000 R. Wistar rats were then infested with 100 to 200 of the irradiated larvae. The rats were sacrificed 35 to 70 days later and the number and maturity of the parasites in the liver were determined. In a second experiment, rats were infested with cercariae irradiated with 1000 to 8000 R doses then reinfested 35 days later with nonirradiated cercariae. In contrast to the finding of 49 parasites in the liver 60 days later after pretreatment with nonirradiated larvae, fewer numbers were found in the rats pretreated with irradiated larvae (18 after 1000 R, 13 after 2000, 6 after 3000 R, 0 after 4000 or 5000 R, and 20 after 8000 R). Thus immunity was apparent after infestation with 4000- or 5000-R irradiated parasites but not after pretreatment with 8000-R irradiated cercariae. The

radioattenuated parasites thus conferred protection against subsequent infestation with virulent organisms. (BBB)

41489 ON THE PRESENCE OF γG AND β_{1C}-GLOBULINS IN RENAL GLOMERULI OF AGING AND NEONATALLY X-IRRADIATED MICE. Guttman, P. H.; Wuepper, K. D.; Fudenberg, H. H. (Univ. of California, San Francisco). Vox Sang., 12: 329-39(1967).

A renal lesion in rodents, termed progressive intercapillary glomerulosclerosis (IGS), is characterized by gradual increase in the thickness of the mesangium due to cell proliferation, clustering, and pleomorphism of the mesangial cells, accumulation of PAS-positive mesangial matrix, and progressive increase in the thickness of capillary basement membranes. Electron microscopy reveals deposits of electron-dense material suggestive of plasma proteins in the mesangial matrix and basement membranes. IGS appears early in life and progresses with age. Whole-body x irradiation or direct irradiation of the kidneys causes acceleration of the glomerular lesion. Kidneys were obtained from BALB/c and Swiss-Webster mice untreated or exposed to whole-body x ray 400 to 500 rad) at the day of birth. The presence of γG- and β_{1C}-globulin was demonstrated in the renal lesions of IGS of both aging and irradiated mice by means of fluorescent antibody techniques. The extent of deposits and intensity of fluorescence paralleled the severity of the disease. Evidence is presented that these deposits may represent local complexes of antigen-antibody and complement. The possible role of autoimmunity in the pathogenesis of the kidney lesions in aging and irradiated mice is considered in light of these observations. It is suggested that the spontaneous renal lesion augmented in the irradiated mouse provides a valuable model for studying the interrelations of genetic predisposing factors of autoimmunity and aging. (BBB)

41490 . RADIOLOGISTS AND RADIATION. Lancet, 1: 35 (Jan. 7, 1967).

When it was suggested in 1956 that radiologists in the United States had not only been more liable to leukemia than the general population but had also been dying earlier from some nonspecific effect, the data were challenged as statistically vulnerable. There was no question about the leukemia, but doubts were raised about the premature aging evidence. It has since become clear that there was such an effect in U.S. radiologists, but a new analysis indicates that it started to diminish in 1935 and had disappeared by 1960, presumably because maximum permissible dose levels were being satisfactorily observed. Similarly, the excess of leukemia in U.S. radiologists has fallen over the years; and again the implication is that safety precautions were being more strictly applied. A striking point in the new data is the different age pattern of leukemia in radiologists and in U.S. white males over 25: no leukemia was observed in radiologists before the age of 40, yet in the general population the proportion of deaths attributed to leukemia is highest in the under-40 group. This contrast points to a different leukemogenic mechanism in radiologist, very likely originating from their occupational exposure. (BBB)

41491 THE EFFECT OF OCCUPATIONAL RISK ON THE REPRODUCTIVE FUNCTIONS OF WOMEN ENGAGED IN MINING AND DRESSING OF RADIOACTIVE RAW MATERIALS. Mueller, C.; Kubat, M.; Marsalek, J. (Charles Univ., Prague). Zentralbl. Gynaekol., 84: 561-68(1962). (In German).

Changes in the periodicity and characteristics of menstruation and in fertility were used to measure the effect of small doses of ionizing radiation in 112 women engaged in mining and dressing of U and Ra ores. The irradiation to which the women were subjected included doses of α, β, and γ radiation from radioisotopes retained on hair, skin, or clothing, and inhalation or incorporation of aerosols into tissues and organs. Many of the women had various subjective complaints, but in general the menstrual cycles and the degree of blood loss was normal. There was some evidence for slight decreases of prothrombin time. In one of the subjects who was ovariectomized, autoradiograms prepared from the ovaries showed numerous α tracks from ^{238}U deposited in them. These results suggested that ionizing radiation from deposited U or Ra may have had some role in affecting the reproductive functions of the women studied, although no connection could be demonstrated between absorbed dose of ionizing radiation and disturbances of menstruation. The reproductive fertility of the women studied apparently was unaffected by the menstrual disturbances reported. (BBB)

41492 SIDE-EFFECTS OF GYNECOLOGIC SUPERVOLTAGE THERAPY. Oberheuser, F. (Univ.-Frauenklinik, Hamburg-Eppendorf, Ger.). Geburtsh. Frauenheilk., 26: 803-6(May 1966). (In German).

Survival rates were compared between patients treated for gynecological tumors with Ra implantation plus either conventional x irradiation, supervoltage, x irradiation from a betatron, or ^{60}Co gammatron. For yr 1, 2, 3, 4, and 5 postirradiation when 174, 170, 154, 145, 135 patients were observed the survival rates after conventional x irradiation were 87, 67, 59, 53, and 50%, respectively. Corresponding survival rates in patients treated with supravoltage x irradiation where 310, 219, 147, 84, and 41 were observed in the postirradiation yr 1 to 5 were 92, 75, 73, 68, and 54%, respectively. In 1131 patients treated for gynecologic tumors with conventional x irradiation 3.3% developed anal radiofibrosis, but out of 413 treated with supervoltage irradiation 1.7% developed this complication. In 57 tumor patients without recurrences 15 were found after 1 yr observation to have obstructed flow in the efferent urinary tract after conventional x irradiation. After supervoltage therapy 2 out of 25 patients showed this side-effect of treatment. (BBB)

41493 PERIPHERAL BLOOD CHANGES AFTER ADMINISTRATION OF INTERNAL EMITTERS. IV. INFLUENCE OF RADIOSODIUM, ^{24}Na. Dienstbier, Z.; Vitek, F. (Charles Univ., Prague). Sb. Lekar., 69: 7-11(1967). (In Czech).

Effects of ^{32}P, ^{198}Au, ^{131}I, and other radioisotopes, which are selectively distributed in the body, on hematopoiesis have been frequently examined, but fewer data are available on the more homogeneously distributed radioisotopes, such as radiosodium. A study was conducted on the peripheral blood changes following intravenous administration to rats of $^{24}NaHCO_3$ (0.5, 8.5, and 12 μCi ^{24}Na per 160 to 180 g of body weight). The results revealed a significant lymphopenia which caused a general leucopenia. The drop in counts and persistence of this change depended on the amount of administered isotope. Neutropenia was less marked than after external irradiation at equivalent doses, as was thrombopenia. Reticulocytosis, which was observed previously after administration of ^{32}P, ^{198}Au, and ^{131}I, was seen only after administration of the lowest dose of ^{24}Na (0.5 μCi). (BBB)

41494 NUCLEAR HEMATOLOGICAL AND RADIATION BIOLOGICAL RELATIONS. Hajdukovic, S. (Inst. of Nuclear Sciences Boris Kidric, Vinca, Yugoslavia); Szirmai, E. Agressologie, 8: 99-134(1967).

This review, with 75 references, considers the following topics: mode of action of ionizing radiations on hematopoietic cells, differential radiosensitivity of cell types, the time factor in radiosensitivity, abscopal effects, repair processes, residual injury, nuclear and chromosomal responses to irradiation, and effects of irradiation on immunogenic reactions. The effect of irradiation on blood cell-forming tissues represents the sum of responses of various types of cells, which are involved in blood cell formation. The radiation response where proliferative mitoses are present is quite different compared with that in the mature cell compartment where only mature cells are present. Intermitotic death and delayed mitosis offer an explanation of what is observed in the blood cell-forming tissue after irradiation leading to aplasia. The disappearance of peripheral blood cells is related to their biological lifetime. The shorter the life-span, the faster their disappearance from the blood. However, disappearance of erythrocytes is much faster than it would be expected. The disappearance rate of peripheral blood cells after irradiation is discussed. (BBB)

41495 SUCCESSFUL REPEATED PLATELET-TRANSFUSION IN RADIATION-INDUCED BONE-MARROW FAILURE. Rose, Michael S. (Royal Marsden Hospital, London). Lancet, 1: 309 (Feb. 11, 1967).

Radioinduced bone marrow injury and its treatment in a 19-yr-old girl are reported. She was treated with 250-kV external x radiation for Hodgkin's disease, but this was discontinued because of transient neutropenia and thrombocytopenia. Later she was given 150 mCi of intralymphatic colloidal ^{198}Au; within 20 days of the second infusion the platelet and leucocyte counts fell sharply. Subsequently, fresh blood and platelet concentrates were transfused and, 13 weeks after the first infusion of ^{198}Au, the platelet and leucocyte counts returned to normal values. Over the nine weeks during which transfusions were given she received six pints of fresh blood and concentrated platelets from 136 pints of blood. (BBB)

41496 PRESERVATION OF FRESH WHITEFISH WITH GAMMA RADIATION. Ostovar, K. (Dept. of Fisheries of Canada, Winnipeg); Slusar, M.; Vaisey, M. J. Fish. Res. Board Can., 24: 9-19(Jan. 1967).

The storage life of fresh whitefish (Coregonus clupeaformis) was extended considerably by the use of low levels of ^{60}Co γ radiation. On the basis of bacteriologic and sensory evaluations, a dose of 150,000 rads proved to be the most effective treatment; the samples exposed to this level of radiation were judged acceptable after 29 days of storage in ice. Fish treated with 75,000 rads were acceptable after 22 days whereas those treated with 300,000 rads, though bacteriologically acceptable, received lower taste scores. Bacteriologic studies showed that nonirradiated fresh samples were dominated by Gram-negative microorganisms be-

longing to the genera Pseudomonas, Achromobacter, and Flavobacterium. Samples treated with 150,000 rads showed survival of Gram-positive microorganisms belonging to the genera Corynebacterium and Micrococcus; these were replaced by Gram-negative microorganisms after 29 days of storage. (BBB)

41497 ANTIBODY RESPONSE OF THYMECTOMISED RATS AFTER LOCAL IRRADIATION OF THE SPLEEN. Sljivic, V. S. (Boris Kidric Inst. of Nuclear Sciences, Belgrade); Petrovic, M. Z. Nature (London), 215: 868-9(Aug. 19, 1967).

The haemolysin response of rats given a massive dose of x radiation to the exteriorized spleen a few minutes after antigen injection was found to be essentially normal except for a delay of about 2 days. It was also shown that the antibody response under these conditions is almost completely prevented either by splenectomy during the latent period or by sub-lethal whole-body irradiation within a few hours of local spleen irradiation. This indicates (a) splenic origin of haemolysin formation, and (b) the role of non-splenic lymphoid sites in restoring the antibody response. The study described was made in order to discover the origin of lymphoid cells repopulating the locally irradiated spleen. Rats were thymectomized at 4 weeks, and 3 months later some were immunized by an intravenous injection of sheep red blood cells; within a few minutes the spleen was exteriorized and locally irradiated with 10,000 R x radiation. Sera were then titrated for haemolysins. There was no essential difference in the antibody response between rats thymectomized at 1 month and given local spleen irradiation 3 months later, and non-thymectomized controls. This indicates that cells responsible for restitution of the antibody-forming capacity of the heavily irradiated spleen do not come directly from the thymus, and that their response to the antigen localized in the spleen is not dependent on the thymus. It also suggests that during the first month of life rats are provided with a sufficient number of immunologically competent cells which does not decrease substantially during the next 3 months. Local irradiation of the spleen somewhat modified the haemolysin response to sheep red blood cells injected immediately before exposure. The antibody response was delayed for about 2 days, but normal peak titres were reached during a significantly shorter rise to peak and at a much higher rate of antibody accumulation. (UK)

41498 DYNAMICS OF PERIPHERAL BLOOD CHANGES IN RELATION TO COMBINED EXTERNAL RADIATION AND THE ACTIVATION OF ^{24}Na IN RATS. [PART] I. Kofranek, V.; Pospisil, J.; Dienstbier, Z.; Arient, M. (Research Inst. of Radiation Hygiene, Prague). Cas. Lek. Cesk., 106: 201-10(Feb. 1967). (In Czech).

Dynamics of peripheral changes of leukocytes, lymphocytes, and neutrophils in rats were investigated one to 29 days following irradiation at doses of 25, 100, 600, and 1000 R from various sources. Lymphocytes were the most radiosensitive of the cells studied. From the changes in number, it was possible to determine the dose and kind of radiation (gamma, neutron, and x-ray) that was applied. (auth) (CFSTI)

41499 RADIATION NECROSIS OF THE BRAIN IN ACROMEGALY. Peck, Fremont C. Jr.; McGovern, Edward R. J. Neurosurg., 25: 536-42(Nov. 1966).

Radioinduced injury of brain is reviewed, and 3 cases are described wherein large doses of external irradiation produced delayed destructive lesions of cerebral tissue. In each case, craniotomy was necessary, in one bilaterally, for the removal of necrotic gliomatous masses. A total dose of 9775 R of 250-KV x rays was given to the first patient. Six months later he developed right-sided convulsions, progressive aphasia, and right-sided paresis. Pathological findings after surgery showed edematous gyri with large areas of necrosis and hemorrhage alternating with other areas where extensive neutrophilic infiltration intermingled with lymphocytes, macrophages, and gitter cells. The small blood vessels were congested, their walls hyalinized and the site of fibrinoid degeneration. The second patient received a total of 10,126 R betatron radiation to the pituitary and showed a good clinical response. However, symptoms of brain injury were noted in about 6 months. Biopsied temporal lobe contained fibrotic nodules microscopically showing marked gliosis with small areas of necrosis and Ca deposits. In other regions there were diffusely scattered polymorphonuclear leucocytes and a marked increase in microglia. There was considerable thickening of the walls of the smaller blood vessels and a collection of lymphocytes surrounded them. In the 3rd case 3 × 3 cm opposing ports were used to administer ^{60}Co γ rays to the sella turcica for a total dose of 8150 R. Transitory diminution of symptoms followed, but less than a year after the last course of radiation therapy, headaches recurred and the patient began having sensations of numbness and tingling with progressive impairment of memory. Biopsied brain revealed extensive vascular changes with marked endothelial proliferation, reduplication, hyalinization of basement membranes, and thrombosis. In some foci there was a peculiar lymphocytic perivascular infiltrate, as seen in syphilis. A 4th case, that of a chromophobe adenoma, treated by a single, rather rapid course of conventional rotational therapy provides another example of radiation necrosis, in this case ending fatally. (BBB)

41500 HERPES-TYPE VIRUS AND CHROMOSOME MARKER IN NORMAL LEUKOCYTES AFTER GROWTH WITH IRRADIATED BURKITT CELLS. Henle, Werner; Diehl, Volker; Kohn, Gertrude; zur Hausen, Harald; Henle, Gertrude (Univ. of Pennsylvania, Philadelphia). Science, 157: 1064-5(Sept. 1, 1967).

Cultured cells derived from male patients with Burkitt's lymphoma and harboring herpes-type virus particles were lethally irradiated. These irradiated cells induced normal peripheral leukocytes of female infants to grow within 2 to 4 weeks after mixed cultivation. Cells of a line free of this agent failed to stimulate growth. If either type of cell was cultured separately, it did not survive under the experimental conditions. Herpes-type viral antigen and C-group chromosomal marker previously described in cultured Burkitt cells were found in all of the female cell cultures that were obtained. (auth)

41501 "A"-ANTIGEN VARIATION IN PIGEON ERYTHROCYTES. I. EFFECT OF X-IRRADIATION ON THE "A"-INAGGLUTINABLE CELL FREQUENCY. Hierholzer, John C.; Scheinberg, S. L.; Hansen, P. A. (Dept. of Agriculture, Beltsville, Md. Univ. of Maryland, College Park). Blood, 30: 219-28(Aug. 1967).

Experiments were carried out on the nature of A-inagglutinable cells. The effect of x-rays on the inagglutinable cell frequency was determined in pigeons by comparing the frequency before and after irradiation. Initial results in the treated birds were highly variable. Considerable reduction in the variability of response was obtained by control of dose, agglutinogen titer, breed, age and sex. Data were also obtained showing that there were individual differences in response to irradiation. Significant increases in the frequency of the inagglutinable cells over that of the controls were obtained for both males and females at 2 and 4 months following irradiation with 360 R. The relation of cell age to inagglutinability was tested by comparing the inagglutinable cell frequency of isolated young cells with that of the total cell population. The comparable frequencies which were observed indicate that cell age is not related to A-inagglutinability. (auth)

41502 CHANGES IN THE VASCULAR SUPPLY TO RAT GROWTH CARTILAGE DURING RADIATION INJURY AND REPAIR. Kember, N. F.; Coggins, Judith (Royal Free Hospital, London). Int. J. Radiat. Biol., 12: 143-51(1967).

The effects of x-irradiation on the epiphyseal blood supply to the growth cartilage in rats are described over a 12-week period after irradiation; 900 rads had very little effect on the blood supply and 1800 rads reduced the supply. A substantial fraction of vessels remained intact throughout the experimental period. Radiation effects on the metaphyseal vessels are also described. (auth)

41503 INCREASED LITTER SIZE IN THE RAT X-IRRADIATED DURING THE ESTROUS CYCLE BEFORE MATING. Hahn, Eric W.; Ward, William F. (Univ. of Rochester, N. Y.). Science, 157: 956-7(Aug. 25, 1967).

Average numbers of ovulations, implantations, and living fetuses obtained from rats x-irradiated during the estrous cycle before mating were found to be a function of both the radiation dose and the time of exposure during the cycle. Animals irradiated during metestrus or the day thereafter exhibited significant increases in the factors studied, while those irradiated on the third day after metestrus maintained fewer implantations after exposure to 300, 500, and 600 R, and fewer living fetuses after exposure to 100 to 600 R. (auth)

41504 THE EFFECTS OF DEUTERIUM ON LIVING ORGANISMS. Misra, Pyari Mohan (Ravenshaw Coll., Cuttack, India). Curr. Sci. (India), 36: 447-53(Sept. 5, 1967).

The effects of deuterium on animals, microorganisms, and plants and the reasons for the biological effects of deuterium on these organisms are discussed and reviewed. (B.H.S.)

41505 OXYGENATION OF BLOOD IN IRRADIATED ANIMALS PRE-ADAPTED TO HYPOXIA. Akopyan, N. S. (Erevan State Univ.). Biol. Zh. Arm., 20: No. 2, 73-8(Feb. 1967). (In Russian).

The arterial blood of rabbits, normally 94% saturated with oxygen, showed 79 to 81% saturation immediately after the animals were placed in a chamber that simulated pressure at 7000 meters altitude. In 15 minutes, values were 75 to 85% but returned to normal when normal pressure was restored. After a 30-day adaptation of the animals to hypoxia, the blood was

85% saturated with oxygen when they were placed in the chamber. Immediately after x irradiation at a dose of 800 R, values of the adapted animals were higher; 10 to 20 days later values were several units lower; and 30 days after irradiation values were almost back to normal in survivors. Erythrocyte counts and hemoglobin concentrations were slightly higher in adapted animals, and even lower in irradiated nonadapted. Adaptation also increased the survival rate of irradiated animals. (TTT)

41506 INFECTIOUS COMPLICATION IN RADIATION CHIMERAE CAUSED BY HAEMOBARTONELLA. Koval'chuk, L. V.; Zaretskaya, Yu. M. (Inst. of Biophysics, Moscow). Zh. Mikrobiol., Epidemiol. Immunobiol., No. 8, 100-2(Aug. 1967). (In Russian).

Pathogenic effects of Haemobartonella muris, ordinarily a saprophyte, were revealed in a rat-mouse chimera. Owing to a reduction in immunity, the rickettsiae caused homolytic anemia that increased the possibility of secondary infections. (auth)

41507 THE EFFECT OF MEAN AND ABSOLUTE LETHAL DOSES OF IONIZING RADIATION ON PORPHYRINURIA OF EXPERIMENTAL ANIMALS. II. PORPHYRINURIA IN WHITE RATS FOLLOWING A SINGLE WHOLE-BODY X IRRADIATION WITH 1100 R. Kolesar, D. (Univ. Komenskeho, Bratislava). Bratislav. Lek. Listy, 46: 465-71(Apr. 30, 1966). (In Slovak).

The course of porphyrin excretion in the urine was followed in Wistar rats exposed to whole-body ionizing radiation Two groups of rats were studied: those which showed initially low levels of porphyrinuria and those with high levels before irradiation. Littermates were irradiated with absolutely lethal doses of 1100 R of x rays. It was found that in the first days after irradiation there was a moderate rise in porphyrinuria. The rise was statistically significant as compared to values prior to irradiation. Paper chromatographic studies showed that the main derrangement in postirradiation porphyrinuria following exposure to an absolutely lethal dose was in the type of porphyrins excreted. Porphyrins containing higher numbers of carboxyl groups, including uroporphyrins, appeared. This was explained by a marked interference with prophyrin biosynthesis by large doses of x rays. (BBB)

41508 THE EFFECT OF MEAN AND ABSOLUTE LETHAL DOSES OF IONIZING RADIATION ON PORPHYRINURIA IN EXPERIMENTAL ANIMALS. I. PORPHYRINURIA IN WHITE RATS AFTER A SINGLE WHOLE-BODY IRRADIATION WITH 600 R OF X RAYS. Kolesar, D. (Univ. Komenskeho, Bratislava). Bratislav. Lek. Listy, 46: 69-83(Jan. 31, 1966). (In Slovak).

To follow the postirradiation porphyrinuria after exposure to a single dose of 600 R (mean lethal dose) of whole-body x radiation, two groups of rats with different degrees of spontaneous porphyrinuria before irradiation, not exceeding the upper limit of normal, were studied After exposure to x rays, in the first group of animals, in which the mean control value of porphyrins excreted was 1.523 ± 0.259 μg/24 hr, porphyrinuria rose to 8.871 the first day; during the second day it gradually fell below the upper limit of normal, but the arithmetic mean of all values of excreted porphyrins following irradiation up to the death of the animals amounted to 4.264 ± 0.542. These animals all died in the course of the first week. In the second group, the rats excreted considerably lower amounts of porphyrins prior to irradiation (0.544 ± 0.042 μg/24 hr); porphyrinuria was not substantially influenced in the first weeks after a lethal dose of 600 R. These animals survived for more than 30 days. The rise in porphyrinuria in the rats after exposure to 600 R was considered to be an unfavorable prognostic sign and depended to a certain extent on the porphyrinuria found before irradiation. By qualitative analyses the porphyrins excreted were found to be represented in both series of animals by coproporphyrin III. In no case did porphyrins appear that contained more carboxyl groups than in coproporphyrins. (BBB)

41509 THE EFFECTS OF IONIZING RADIATION ON THE LONGEVITY OF PLOIDY TYPES IN THE WASP MORMONIELLA VITRIPENNIA. Clark, Arnold M.; Cole, Kenneth W. (Univ. of Delaware, Newark). Exp. Gerontol., 2: 89-95(1967).

The adult life span of M. vitripennis is influenced by the kinds of genes present rather than by the number of sets of chromosomes. Diploid males were more resistant than haploid males to ionizing irradiation. Diploid and triploid females were equal in radiation sensitivity. The data reported did not support the somatic mutation theory of aging and indicated further that the types of injury leading to natural aging were different from those leading to radioinduced decrease in life span. Although the data indicate that some type of nuclear injury is induced by ionizing radiation, the precise nature of the injury is still obscure. This is presumably because of the many physiological events that occur between initial radioinduced injury and death in a multicellular organism. (BBB)

41510 EVALUATION OF THE MECHANISM OF SOME PHYSICAL EFFECTS OF LASERS ON TISSUE. Mendelson, Janice A.; Cook, Norman D.; Dearman, James R. (Edgewood Arsenal, Md.). Mil. Med., 132: 270-81(Apr. 1967).

Possible injury to man from accidental exposure to a laser beam was evaluated from studies on animal tissues. The potential thermal effects from the standpoint of acute injury were divided into two groups: effects of coagulation of the protein of the tissue thus damaging or killing the portion involved, and effects of vaporization. When a focused ruby laser beam was applied to the skin, liver, or lung of small animals, circumscribed cone-shaped holes with a narrow rim of coagulation resulted. Similar effects could be obtained with high-frequency current as used in electrosurgical apparatus. Vaporization removed the central portion of the target. In tissue, it left a hole not exceeding about two mm in dia, whether about 700 J was delivered in a 4.8-mm dia spot size, which was the highest energy density achieved, or, using other lenses, in up to 20 mm total spot size. This small hole would not be a significant wound to the skin of man. The deeper effects, as seen on histological examination, included necrosis of collagen and elastic fibers and leukocytic infiltration consisting mainly of round cells. These were noted a week later in the intact animal. Because of the very rapid, intense heating, a jet of vaporized tissue was produced. It was concluded that, except for the eyes, from the surgical standpoint, only superficial damage could result from accidental exposure of man or large animals to lasers. Experimental data tended to confirm the theoretical principles involved. (BBB)

41511 HOW RADIATION CAUSES CELL DEATH. Whitfield, James F. (Euratom Joint Research Center, Ispra, Italy). Bio-Med. Eng. (London), 2: 78-81(Feb. 1967).

Biological effects of ionizing radiation in the lethal range are reviewed, and an account is given of the sequence of events that follow irradiation of a rat thymocyte with 25 to 1500 R of x rays. (BBB) (TSS)

41512 EFFECTS OF DIAGNOSTIC X RAYS ON CHROMOSOMES IN INFANTS: A PRELIMINARY REPORT. Reisman, Leonard E.; Jacobson, Ahren; Davis, Lawrence A.; Kasahara, Shoichi; Kelly, Sarah (Univ. of Louisville, Ky.). Radiology, 89: 75-80(July 1967).

Previous limited studies suggested that diagnostic x-ray procedures may cause chromosomal damage. This investigation was designed to evaluate the effect of diagnostic x rays on the chromosomes of the neonate. Chromosome studies in a group of 30 infants, using a microtechniques, were carried out prior to the varying x-ray procedures, and serially at intervals from one hour up to several months after exposure. Although analyses of the postirradiation chromosome cultures do not reveal a statistically significant increased incidence of chromosomal abnormalities, several individual infants did not have evidence of chromosomal damage. These findings in relation to the varying x ray dosage levels are discussed. (auth)

41513 RESPONSE AND RECOVERY OF LIVER TO RADIATION AS DEMONSTRATED BY PHOTOSCANS. Kurohara, Samuel S.; Swensson, Norman L.; Usselman, James A.; George III, Frederick W. (Naval Hospital, San Diego, Calif. Roswell Park Memorial Inst., Buffalo). Radiology, 89: 129-35(July 1967).

Radiogold (^{198}Au) and rose bengal (^{131}I) liver photoscans were obtained in 39 cancer patients, 31 being those with testicular carcinoma before, during, and/or after radiotherapy, using portals involving usually part of the liver. This technique was demonstrated to be a consistently more sensitive indicator of hepatic response to segmental irradiation than the conventionally used systemic liver function tests. The information gathered on hepatic response and recovery to segmental irradiation under radiotherapeutic conditions, as assessed by photoscans, may be summarized as follows: the threshold dose-time value of response, i.e., the reduction or ablation of photodensity in the irradiated portion, is approximately 3,000 rads delivered in thirty days; these changes are reversible, at least partially, even after radiotherapeutic doses of 4,000 to 5,200 rads, provided the entire liver is not exposed to these levels; and the reticuloendothelial component of liver tissue appears to be more radiosensitive than the hepatocellular component. (auth)

41514 LOCALIZED RADIATION HEPATITIS AS DEMONSTRATED BY SCINTILLATION SCANNING. Concannon, Joseph P.; Edelmann, Abraham; Frich, John C. Jr.; Kunkel, George (Allegheny General Hospital, Pittsburgh). Radiology, 89: 136-9(July 1967).

A unique defect was observed in the scintillation scans of the liver in 6 patients in whom the liver was irradiated to doses in the range of 4,000 to 5,000 rads. Segmental irradiation of the liver to these doses was not followed by clinical symptoms and

signs of radiation hepatitis nor by consistent alterations in liver function studies. Chemotherapy contributed little, if any, to the production of the scanning defect since 3 patients who were treated by radiation therapy alone also exhibited the characteristic scanning defect. The diminished radioactivity noted after segmental irradiation of the liver may be a direct radiation effect on the functional capacity of the Kupffer cells or may be due to a radiation effect on liver parenchyma, sinusoids, and blood vessels, preventing the colloidal gold particles from reaching active Kupffer cells. (auth)

41515 DISTRIBUTION OF REIMPLANTED BONE MARROW CELLS AND DEVELOPMENT OF FOCI OF DONOR HEMOPOIESIS IN IRRADIATED RECIPIENTS. Zaitseva, K. K. (Military Medical Academy, Leningrad). Byull. Eksp. Biol. Med., 63: No. 6, 107-11(June 1967). (In Russian).

Mice of the CC57W strain, irradiated with x rays (700 R) received intravenously heterologous (rat) bone marrow 24 hours after irradiation. Identification of the donor cells was carried out histochemically by detecting alkaline phosphatase in the rat granulocytes. Five minutes after transplantation donor granulocytes are primarily deposited in the lungs. Two hours later recirculation took place with migration of heterophils into the spleen, liver, and bone marrow. A day after grafting the number of the donor cells in the organs and in the blood drops considerably, and after 2 to 3 days they were no longer detectable. Secondary increases of the number of the donor cells of the granulocyte series took place from the fourth day after grafting and is accompanied by appearance of numerous foci consisting of cells of the white series in the spleen, bone marrow, and the liver of the irradiated recipients. (auth)

Radiation Effects on Plants

Refer also to abstracts 41379, 41380, and 41473.

41516 ABSENCE OF AN OXYGEN EFFECT AND THE GENETICALLY DETERMINED REPAIR PROCESSES. Davies, D. R. (Atomic Energy Research Establishment, Wantage, Eng.). Nature (London), 215: 829-32(Aug. 19, 1967).

It is generally observed that cells exposed to sparsely ionizing radiation in the presence of oxygen suffer more damage than in its absence. The extent of enhancement varies with organism and strain, environmental conditions, and the criterion of damage. Exceptions to this behavior are bacteriophage and transforming principle. It has also been observed that uv-sensitive bacterial mutants frequently show a smaller oxygen enhancement ratio than their parental strains. Some studies are reported on several mutant strains of the unicellular green alga Chlamydomonas reinhardi, highly sensitive to uv light, and the enhanced sensitivity of which is probably caused by a defective capacity for repairing damage. The response to gamma radiation of a class of mutants more sensitive than the parental form only when irradiated in the absence of oxygen is described. It is concluded that this unusual effect is controlled by one gene. (UK)

41517 NORMAL AND GAMMA-RAYED RESTING PLUMULE OF BARLEY. Mullenax, R. H.; Osborne, T. S. (Univ. of Tennessee, Oak Ridge). Radiat. Bot., 7: 273-82(1967).

Seedlings from caryopses given 0, 15, or 30 kR of γ-radiation initiated 35 to 45 new structures in the first 10 days. After 5 weeks, no trace could be found of the bud in the coleoptilar axil, which had been the largest branch bud in the resting embryo. It was inferred that this bud may act as a reserve in case mishap should occur to the apical bud during early seedling growth. (auth) (UK)

41518 STUDIES OF THE VITAMIN C CONTENT OF SOME CULTIVATED PLANTS AFTER CHRONIC AND ACUTE γ IRRADIATION. Hosek, K.; Pleticha-Lansky, R.; Hodova, H. (Inst. of Experimental Botany, Prague). Abh. Deut. Akad. Wiss. Berlin, Kl. Med., No. 4 379-83(1966).

From Symposium on Electrical Methods and Principles in Molecular Biology, Jena, Ger., May 25-29, 1965. See CONF-650556.

Preliminary results are reported from studies on the effects of γ rays on tomatoes and red peppers. The plants were chronically irradiated in the gamma field using doses of 0.5 to 1.4×10^3 R over the vegetative period (927 hrs). Polarographic estimation of the l-ascorbic acid content showed that under these irradiation conditions no vitamin was destroyed. Therefore the mechanisms of the biosynthesis of ascorbic acid remained unaffected. Normal formation of this vitamin can be assumed in individual plants selected for further breeding. Acute γ irradiation (2.0 to 3.5×10^4 R) of tomato seeds caused a decrease of ascorbic acid content in the first generation. (auth)

41519 PRINTSIPY I METODY PRIMENENIYA RADIATSII V SELEKTSII RASTENII. (Principles and Methods of Radiation Plant Selectivity). Valeva, S. A. Moscow, Atomizdat, 1967. 88p.

Data are given on the mutagenic effects of radiation, radiation effects on plants, units of radiation measurements, and efficient mutagenic doses. Radiosensitivity and mutability in plants are discussed and analyses of various methods of irradiation are analyzed. Genetic and cytological characteristics of the first plant generation following irradiation, and special selection of seeds for sowing the second generation are evaluated. (R.V.J.)

Radiation Effects on Microorganisms

Refer also to abstracts 41362, 41451, 41473, and 41524.

41520 VIRUS–HOST CELL INTERACTION IN RABBIT FIBROSARCOMA PRODUCED BY SHOPE FIBROMA VIRUS. Kato, Shiro; Ono, Kohei (Osaka Univ.). Biken J.; 9: No. 1, 51-61(Mar. 1966).

A study was made of the relation between virus multiplication and tumor cell proliferation in the fibrosarcoma formed in adult white rabbits inoculated with Shope fibroma virus. The results obtained are as follows: In all rabbits treated by ^{60}Co irradiation and subsequent predonisolone administration, tumors appeared at the site of virus inoculation about three days after inoculation and grew progressively over the 30 days. In the untreated controls, fibromata also appeared, reached a maximum size in about nine days, and after 30 days nearly all of them disappeared, leaving only scabbed ulcers. In three of the five irradiated rabbits, several pea-sized tumors appeared in uninoculated areas of the skin on the 26th and 30th day. These secondary tumors also grew progressively, and showed the malignant appearance of a fibrosarcoma; In tumor tissue about 60% of the cells are virus-producing, as shown by the fluorescent antibody technique and autoradiography with ^3H-thymidine as well as by recovery of infectious virus; but these virus-producing cells do not multiply. From these results, fibrosarcoma formation may be explained as follows. Under the immunologically modified conditions, the cycle of virus multiplication proceeds in the tissue. Some factor must make dormant subcutaneous fibroblasts start to proliferate. This factor may be released from the degenerating virus-producing cells. The stimulating activity of this factor appears rather transient, since the tumor growth ceases immediately after the cycle of virus multiplication is blocked by an increase in the amount of neutralizing antibody against the virus. When a rabbit is irradiated, a continuous diffusion of this factor causes the fibroma to continue to grow progressively. As a result, continuously and actively proliferating fibroma cells may be transformed into fibrosarcoma cells. (auth) (NSA of Japan)

41521 X-RAY INACTIVATION OF LAMBDA PHAGE. II. REACTIVATION PROCESSES. Hradecna, Zdenka (Univ. of Geneva). Int. J. Radiat. Biol., 12: 169-76(1967).

Studies on the reactivation processes affecting x-ray survival of lambda phage revealed that the x-ray lesions were not the subject of an enzymatic repair and differed in this respect from uv lesions. Specifically no host-cell reactivation or photoreactivation was detected. Multiplicity reactivation, the other repair phenomenon depending on genetic recombination, was not observed with x-irradiated lambda phage either. Marker rescue was the only significant phenomenon observed with x-ray-inactivated lambda phage. Undamaged parts of the irradiated genome were to a measurable extent incorporated simultaneously with the infecting, non-irradiated phage. (auth)

41522 MUTANTS OF YEAST SENSITIVE TO ULTRAVIOLET LIGHT. Snow, Richard (Univ. of California, Davis). J. Bacteriol., 94: 571-5(Sept. 1967).

Six uvr mutants of Saccharomyces cerevisiue with hypersensitivity to ultraviolet (uv) light were isolated after mutagen treatment with ethylmethanesulfonate. Uv sensitivity ranges from moderate to extreme, and four of the mutants are also sensitive to nitrous acid. Ranking in terms of uv sensitivity does not parallel ranking in terms of nitrous acid sensitivity. Homozygous diploid mutant strains are somewhat less sensitive than the corresponding haploids. All mutations are recessive. None of the mutants is sensitive to γ rays, and each shows photoreactivation after uv radiation. Complementation tests and tetrad analysis indicate that each strain represents mutation in a different gene. Two of the uvr genes are linked, and two others are centromere-linked. (auth)

Radiosterilization and Radiopreservation

Refer also to abstract 41151.

41523 (AECL-2873) POTENTIAL ROLE OF RADIATION IN ALLEVIATING SOME WORLD FOOD PROBLEMS. MacQueen, K. F. (Atomic Energy of Canada, Ltd., Ottawa (Ontario). Commercial Products Div.). Apr. 1967. 64p. (CONF-670522-4). Dep. CFSTI. CAN $1.50.

From International Conference on World Review of Nuclear Reactors and Radioisotopes, Montreal, Canada.

The possibilities of using radiation processing of foods to help conserve and improve the distribution of the world's food supplies are discussed. Applications of radiation processing discussed include: the control of insect infestation of foods; the use of radiation processing to extend the storage life of tropical fruits and vegetables; the use of radiation processing to extend the storage life of fresh fish and seafoods; radiation control of Salmonellae in animal feeds; and the use of radiation as a quarantine control measure to inactivate foot and mouth - virus in carcosses of infected animals. (53 references.) (C.H.)

41524 (NYO-3733-2) MICROBIOLOGICAL ASPECTS OF RADIOPASTEURIZED CHICKEN. Quarterly Report No. 2. Pledger, Richard A.; Chen, Chi-sin (Hazleton Labs., Inc., Falls Church, Va.). Mar. 28, 1967. Contract AT(30-1)-3733. 36p. Dep. CFSTI.

Problems of differentiation, quantification, and recovery of microorganisms in chicken were investigated. An inoculum containing eight genera of bacteria and yeasts was isolated and irradiated. After repeated irradiations only yeasts were observed in the medium. Cultures of enteric microorganisms were irradiated and effects on morphology and growth patterns were observed. Tables showing effects of radiation are presented. Spores of Clostridium botulinum and C. perfringens were irradiated and recovery of spores was carried out by homogenization of chicken with saline. Colonies developing from germinating spores of Clostridium perfringens, but not of C. botulinum, were observed. Techniques for separation and quantification of microorganisms are presented. Studies on recovery of Staphylococcus and Clostridium from chicken indicated that a multiplication of cells occurred during the experimental procedure. Results of these experiments are presented in the form of tables. (H.L.W.)

41525 (PAEC(A)IN-671) FOOD IRRADIATION FACILITIES. A Literature Search. (Philippine Atomic Energy Commission, Manila). Mar. 1967. 23p. Dep.

One-hundred and twenty-five references are presented to literature on food irradiation facilities. (C.H.)

41526 EFFECT OF PASTEURIZING DOSES OF GAMMA RADIATION ON STORAGE LIFE OF COOKED LOBSTER MEAT. Power, H. E.; Fraser, D. I.; Dyer, W. J.; Neal, W.; Castell, C. H. (Fisheries Research Board of Canada, Halifax). J. Fish. Res. Board Can., 24: 221-30(Feb. 1967).

The effect of pasteurization doses (75,000 to 250,000 rad) of ^{60}Co γ radiation on the organoleptic characteristics and storage life of cooked lobster meat stored at 0°C was studied. The initial baterial count of the iced control samples was 6900 colonies per g lobster meat. Irradiation at 75,000 rad reduced the count to 120, at 150,000 and 250,000 rad to less than 100. After 7 days storage in ice at 0°C, the bacterial count per g of the iced control samples had reached 129,000 whereas the count for all irradiated samples was less than 100. The trimethylamine (TMA) values of the iced control meat increased rapidly after 20 days storage to >30 mg N/100 g, while values for the irradiated samples remained below 10 mg N/100 g for 30 days but then increased rapidly. Irradiation with 75,000 to 250,000 rad thus inhibited the growth of TMA-producing bacteria for 10 days longer than on iced controls. Taste panel tests revealed that meats irradiated at 75,000 rad did not differ initially from the iced control meats; scores decreased gradually, as a result of developing acid-sweetish, seaweedy, and stale flavors. Irradiation at 150,000 and 250,000 rad reduced the initial taste scores due primarily to a loss of the sweet, fresh flavor and to the presence of slight irradiation odors and flavors, especially after 250,000 rad. The meats irradiated at 150,000 were acceptable up to 35 days. It was concluded that irradiation at 75,000 rad can be used to extend the storage life, in ice, to between 28 and 35 days for both tail and claw meats from 14 to 21 days for unirradiated iced samples. Higher irradiation levels cause an immediate loss of quality due to toughening and loss of flavor. (BBB)

41527 IRRADIATION OF MANGOES. II. RADIATION EFFECTS ON SKIN-COATED ALPHONSO MANGOES. Dharkar, S. D.; Savagaon, K. A.; Srirangarajan, A. N.; Sreenivasan, A. (Atomic Energy Establishment Trombay, Bombay). J. Food Sci., 31: 870-7(Nov.-Dec. 1966).

The combined effects of radiation and skin-coating on storage life, organoleptic qualities, and control of respiration in mangoes were studied. The mangoes were irradiated under gaseous atmospheres of air, nitrogen, or carbon dioxide. The skins were coated with an emulsion of an acetylated monoglyceride. Skin-coated fruits showed physiological damage presumably due to inhibition of respiration. This defect was rectified by a spurt in respiratory activity when fruits were irradiated in air or nitrogen. Irradiation in carbon dioxide, that also retarded respiration, caused physiological damage that was reversible, the recovery of organoleptic qualities occurring to some extent. Suppression of respiration beyond an optimum level was responsible for irreversible damage to the fruit. Organoleptic evaluation, analysis for fruit constituents, skin color, and pressure tests showed that storage life of the fruit could be increased by combining skin-coating with irradiation under either air or nitrogen. (BBB)

41528 IRRADIATION OF FRUIT. EXPERIMENTAL FACILITIES AND BIOCHEMICAL STUDIES. Romani, R. J.; Bowers, J. B. (Univ. of California, Davis). Contract AT(11-1)-34. pp 357-62 of XVIth Intern. Hort. Congr., Brussels, Aug. 31 to Sept. 8, 1962. Gembloux, Belgium, Editions J. Duculot.

A description is given of a 32,500-Ci ^{60}Co source used for studying effects of ionizing radiation of developmental processes in fruit, and some preliminary results obtained with it. Respiration (CO_2 evolution) rates were determined for some irradiated fruit. Respiration of pears irradiated at two different stages of the climacteric is reported. Irradiation at or near the climacteric peak results in a relatively low respiration response and little manifestation of other irradiation effects such as delayed loss of chlorophyll and decreased rate of softening. By attaching air lines to the irradiation chamber it was possible to measure the respiratory response during irradiation and thus obtain a continuous measure of respiration. Such a respiratory pattern for lemon fruit is shown, revealing differences in respiration response with increasing radiation dose. Although the immediate respiration increase following 50 Krad exposure (10 min) was nominal, there followed a continual rise indicating a definite physiological effect. A difference was apparent between 100 and 200 Krad treatments and the response at 400 and 800 Krad. Respiration during irradiation increased steadily to a point between 200 and 400 Krad where it reached a plateau. Lemons receiving a dose treatment below this plateau (100 and 200 Krad) exhibited an initial burst of respiration which then continued at an elevated level for six hr with only a slight increase in respiration after irradiation followed by a continual rate of decline. After 24 hr, the fruit irradiated at the higher doses had lower rates of respiration than that having received 100 or 200 Krad. Evidently these lemons received a critical amount of irradiation injury somewhere between 200 and 400 Krad. This dose range was also found to encompass the critical limits for irradiation to prolong storage life. At the lower radiation doses the continued high post-irradiation respiratory level was interpreted as an injury response, with the repair mechanisms accounting for an increased metabolism. At the higher doses sufficient damage was caused to the respiratory mechanisms that cellular repair could not take place, resulting in a rapidly declining respiration rate and cell death. Some short-term postirradiation effects in lemons as reflected by changes in the extracted juice are also reported. (BBB)

41529 LIPID OXIDATION AND PIGMENT CHANGES IN FRESH AND IRRADIATED BEEF. Greene, Barbara Estella. Tallahassee, Florida State Univ., 1966. 69p.

Thesis.

Lipid oxidation was studied in radiation sterilized cooked beef by the thiobarbituric acid (TBA) test and by manometric experiments. Malonaldehyde (MA), the lipid oxidation product measured by the TBA test, was found to decrease during storage of meat in sealed cans. Exposing the meat to air did not result in the rapid increase in this product that was noted in unirradiated samples. Pure MA added to cooked meat before radiation and storage had almost completely disappeared after 104 days. To determine whether MA might react with free amines in the meat, solutions of MA and lysine were incubated for several days. This resulted in a colored reaction product which suggested the occurrence of a Maillard reaction. Changes in absorbance spectra indicated formation of a new compound. When measured manometrically, oxygen uptake in irradiated meat was found to be less than that of samples containing an antioxidant. It was proposed that radiation sterilized beef developed lower TBA numbers partly because of a further reaction of MA and partly because of antioxidant formation in the meat itself. Two of the major sources of non-microbial deterioration in prepackaged raw meats are the development of off odors and colors. The relation of these changes to polyunsaturated fatty acid oxidation in the meat was investigated. Lipid oxidation was measured by the TBA test; pigment changes, by reflectance spectrophotometry. Lipid oxidation was found to produce detectable off odors in raw and subsequently cooked beef. Raw beef treated with low doses of ionizing radiations was similarly affected. Propyl gallate and butylated hydroxy anisole effectively inhibited rancid

odors in both fresh and irradiated samples. Radiation sterilized raw beef did not develop oxidative rancidity as measured by the above test. Anaerobic packaging to prevent oxidation of myoglobin and in turn, lipids, appeared to be useful only if packaging (and oxygen removal) could be carried out rapidly and if meat continued sufficient enzyme activity to establish anaerobic conditions quickly and to completely reduce metmyoglobin. Radiation up to 1.0 megarad did not destroy metmyoglobin reducing activity in raw beef. Propyl gallate and butylated hydroxy anisole, even under aerobic conditions offered substantial protection to the fresh meat pigments and at the same time effectively inhibited lipid oxidation. (auth)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstract 41634.

41530 PROCEEDINGS OF THE 2nd INTERNATIONAL POWDER METALLURGY CONFERENCE, STARY SMOKOVEC, CZECHOSLOVAKIA, SEPTEMBER 27–30, 1966. PRESENT-DAY PROBLEMS OF POWDER METALLURGY. VOLUME II. HARD AND HIGH-TEMPERATURE MATERIALS. Prague, Academia, 1966. 247p. (In Several Languages). (CONF-660915-(Vol.2)).

Fourteen papers presented at the conference are included; five are abstracted for NSA. The other nine cover research on the following subjects: the effect of dispersed particles upon the properties of alloys; some problems of preparation of stable films on SAP particles; dispersion-strengthened Al products; recrystallization tests on sintered Ni containing a dispersed Al_2O_3 addition; properties and applications of Re-alloyed W and Mo wires in the production of incandescent lamps and electron tubes; the effect of raw materials and technological parameters on the properties of cemented carbides; monolithic polycrystalline Si; and, new refractory materials on the basis of artificial mica. (J.G.B.)

For abstracts of individual papers see: 41623 and 41663–41666.

41531 PROCEEDINGS OF THE 2nd INTERNATIONAL POWDER METALLURGY CONFERENCE, STARY SMOKOVEC, CZECHOSLOVAKIA, SEPTEMBER 27–30, 1966. PRESENT-DAY PROBLEMS OF POWDER METALLURGY. VOLUME III. SINTERED PARTS (STRUCTURAL PARTS, BEARINGS, MAGNETS, SEMICONDUCTORS). Prague, Academia, 1966. 401p. (In Several Languages). (CONF-660915-(Vol.3)).

Twenty-three papers presented at the conference are included. Topics covered are: studies on sintered copper–lead alloys; antifriction and iron-graphite friction materials; sintered metal bearing performance; statistical theory of strength of porous powder metallurgy materials; effects of additives on case-hardening of sintered-steel parts and properties and sintering of iron powders; preparation and properties of some ferrites; properties of semiconductor materials in $Mn-CoO-O_2$ system; sintered filter fabrication; diamond bearing abrasives made by powder-rolling techniques; and, coextrusion of aluminum-clad cermetallic core rods. (J.G.B.)

41532 PROCEEDINGS OF THE 2nd INTERNATIONAL POWDER METALLURGY CONFERENCE, STARY SMOKOVEC, CZECHOSLOVAKIA, SEPTEMBER 27–30, 1966. PRESENT-DAY PROBLEMS OF POWDER METALLURGY. VOLUME V. SUPPLEMENTS. Rez, Czechoslovakia, Informacni Stredisko UJV, 1967. 93p. (In Several Languages). (CONF-660915-(Vol.5)).

Six papers presented at the conference are included. Topics discussed include: some problems in sintering of oxides, impact densification of metal powders; fabrication of dispersion-strengthened nickel materials; the logarithmic shrinkage law; physical conditions for obtaining higher efficiency of thermoelectric conversion of semiconductive alloys and their solid solutions; and electron sintering mechanism of metal and nonmetal powders. (J.G.B.)

41533 BERYLLIUM METAL HANDBOOK. Hausner, H. H. (ed.). Yonkers, N. Y., General Astrometals Corp., 1967. 68p. $3.00.

Special emphasis is given to structural properties of Be under normal and cryogenic conditions. Thermodynamic data, information dealing with the effect of structure on mechanical properties, as well as data on soldering, brazing, and welding of Be should be useful to metallurgists, mechanical engineers, and designers, in the aircraft, aerospace, missile, and nuclear fields. Particular attention is called to the data on purity of various types of Be metal. Included in the appendix are detailed specifications for Be metal powder and hot-pressed products available commercially. A table is included, which lists hot-pressed Be product specifications, along with equivalent specifications used throughout the Be industry. (67 graphs and tables) (auth)

Corrosion and Erosion

Refer also to abstracts 40957, 41106, 41111, and 41650.

41534 SELF-DIFFUSION COEFFICIENT OF URANIUM IN URANIUM MONOCARBIDE. Villaine, Philippe; Marin, Jean-Francois (Centre d'Etudes Nucleaires, Grenoble, France). Compt. Rend., Ser. C, 264: 2015-18(June 19, 1967). (In French).

U diffusion profiles in UC were studied by a tracer method for temperatures between 1450 and 1980°C. The self-diffusion coefficient for stoichiometric UC is given by the expression $D = 7 \times 10^{-5} \exp - 80{,}000/RT$, the activation energy being 80 kcal/mole + 10 kcal. This coefficient is much larger for substoichiometric carbides, much smaller for superstoichiometric carbides. (tr-auth)

41535 STUDY ON THE ELECTROCHEMICAL BEHAVIOR OF NIOBIUM IN ACID SOLUTIONS. Pagetti, J.; Talbot, J. (Faculte des Sciences, Paris). Corros.-Trait., Prot., Finition, 15: 171-7(June 1967). (In French).

The electrochemical behavior of Nb was studied in acid solutions. An electrolytic-polishing method was developed in order to obtain a well-defined and reproducible surface. The effect of purity of the solution, geometric condition of the surface, and other physical and chemical factors are considered. (auth)

41536 CONTRIBUTION TO THE STUDY OF THE OXIDATION OF ZIRCONIUM AND OF THE DIFFUSION OF OXYGEN IN THE OXIDE AND IN THE METAL. Debuigne, Jean (CNRS, Paris). Metaux (Corros.-Ind.), 42: 89-108(Mar. 1967). (In French).

The oxidation kinetics, at constant temperature, under pure oxygen are analyzed for temperatures from 400 to 1200°C. As Zr has an allotropic transformation at 862°C and as oxygen is very soluble in the metal, principally in the low-temperature α-phases with hexagonal structure, the analysis distinguished between the case of oxidation at temperatures below 862°C and oxidation at higher temperatures. It was found that simultaneously with the formation of a surface layer of oxide, a significant dissolution of oxygen occurs in the subjacent metal. A model of the oxidation process is given. The oxidation of Zr can be treated on the mathematical plane as a diffusion problem in semi-infinite medium with mobile interfaces. Resolution of this problem yields an expression of the diffusion coefficients of oxygen in Zr and the oxide. These expressions were used to calculate from the experimental data the values of the diffusion coefficients of oxygen in α-Zr and β-Zr and in ZrO_2 in the temperature range from 400 to 1200°C. The mode of diffusion of oxygen was analyzed by taking into consideration the physico-chemical peculiarities of Zr–O solid solutions, such as the existence of an ordered distribution of the oxygen atoms. The tendency to deformation of the Zr–O solid solution was analyzed, and dependence of the diffusion coefficients in the α phase on the oxygen concentration was determined. (tr-auth)

41537 EFFECTS OF WATER VAPOR ON ZIRCONIUM CORROSION IN FUSED EQUIMOLAR SODIUM AND POTASSIUM CHLORIDE MIXTURE. Volodin, V. P.; Ozeryanaya, I. N.; Smirnov, M. V. Tr. Inst. Elektrokhim., Akad. Nauk SSSR, Ural. Filial, No. 8, 99-102(1966). (In Russian).

The effects of water vapor corrosion on Zr in a fused equimolar mixture of NaCl–KCl were investigated. It was found that water vapor does not have a noticeable effect on the corrosion of metallic Zr in NaCl–KCl melts at temperatures from 700 to 900°. During preliminary cleaning of the alkali metal chlorides (from inclusions of LiCl) it was recommended that basic attention be given to the removal of O_2 traces. (tr-auth)

41538 PRODUCTION OF A FILM ON THE CORROSION OF EXTRA-MILD STEEL BY URANIUM HEXAFLUORIDE. Hasson, R. (CEN, Saclay, France). Microsc. Cryst. Front, 15: 301-8(Jan.-Feb. 1967).

A photographic film shown at a symposium on Applied Microscopy at Sheffield, England, in 1965 is described. The film shows that after an induction period lasting several minutes the metal surface rapidly became covered with an interference film. The thickness of this film depended on the crystalline orientation of the metal. Preferential attack on the impurities in the steel (mainly $Mn(SO_4)_2$) was observed. These impurity inclusions became covered with crystals of a uniform subfluoride, which developed largely in the lateral directions. After a period of general growth during which evolution of the interference film continued, together with development of the crystals centered on the inclusions, transparent crystals appeared and extended laterally to cover the whole surface. The end of this phase was marked by a reorganization of the corrosion products and continued crystal growth. Various sub-fluorides of uranium were produced. The whole process is shown to be extremely complex. (UK)

41539 OXIDATION OF MOLYBDENUM PARTICLES BY ELECTRON MICROSCOPY AT VARIOUS TEMPERATURES. Vahldiek, F. W.; Pence, R. E. (Air Force Materials Lab.,

Wright-Patterson AFB, Ohio). J. Less-Common Metals, 13: 448-56(1967).

A procedure using Ti films as getter is described which allows electron microscopy study on fine particles of Mo at high temperatures with a minimum in oxidation. Spherical Mo particles ranging from 0.31 to 0.85 μ in dia were studied for oxidation in regular time intervals up to 1 h at various temperatures up to 600°C, in vacuum, with and without Ti thin films as getter. It was determined that appreciable oxidation (0.11 Å/sec) occurred even at beam temperatures (≈170°C) without Ti as a getter. Oxidation rates determined without Ti getter from 200 to 400°C were found to range from 0.26 to 0.28 Å/sec for a 1 h period. The rates measured with Ti getter from 200° to 400°C were found to range from 0.01 to 0.04 Å/sec for the same time period. At 600°C a substantial decrease in the oxidation rate was observed with increasing particle diameter, without Ti films, ranging from 0.32 Å/sec (0.37 μ particle) to 0.28 Å/sec (0.85 μ particle) for a 1 h period. The oxidation rate with Ti getter ranged from 0.05 Å/sec (0.32 μ particle) to 0.033 Å/sec (0.76 μ particle) for the same time period at 600°C. High temperature X-ray diffraction on thin layers of Mo particles showed an increase in oxidation as monoclinic MoO_2 up to 400°C. From 400° to 750°C a decrease in MoO_2 was observed. (auth)

41540 YTTRIUM OXIDATION AT LOW PRESSURES. Vorob'ev, V. V.; Ryabchikov, L. N. Izv. Akad. Nauk SSSR, Metal., No. 3, 226-7(May-June 1967). (In Russian).

The method and results of the investigation of Y oxidized under O_2 pressure of 1×10^{-5} to 1×10^{-4} mm Hg in temperature range of 500 to 700°C are described. The graphs of Y oxidation rate indicated that the amount of absorbed O_2 per 1 cm^2 of Y specimen surface at various temperatures, increased with increased rate of O_2 influx. (R.V.J.)

41541 ON THE INFLUENCE OF QUENCHING SPEED AFTER ANNEALING IN THE β-REGION ON THE CORROSIVE BEHAVIOR OF ZrNb 2.5. Beyer, B.; Paetzold, V.; Juknat, R. (Forschungsinstitut fuer NE-Metalle, Freiberg i. B.). Kernenergie, 10: 189-93(June 1967). (In German).

A device for heat treatment and controlled cooling of Zr-2.5 wt % Nb alloy is described, based on Van Arkel Zr. Test conditions for cooling rates ranging from 21.6 to 0.02 deg/s are given. Corrosion tests in a pressurized-water autoclave have resulted in a critical cooling rate of about 1 deg/s for achieving sufficient corrosion resistance. The test results on the basis of metallographic and x-ray investigations as well as hardness are discussed and the results are interpreted. (auth)

Preparation and Fabrication

Refer also to abstracts 40957, 41156, 41575, 41645, and 42842.

41542 (BM-RI-7023) ELECTRODEPOSITION OF IRIDIUM FROM FUSED SODIUM CYANIDE AND AQUEOUS ELECTROLYTES. A Preliminary Study. Andrews, R. L.; Kenahan, C. B.; Schlain, David (Bureau of Mines, Washington, D. C.). Sept. 1967. 12p.

Means of electrodepositing iridium to form thick coatings suitable for the protection of such metals as W and Mo, which oxidize rapidly at high temperatures are investigated. Using a fused NaCN bath, thick, adherent, and coherent deposits of Ir up to 15 mils thick were plated on W and Mo substrates at 600°C and current densities of 10 to 100 ma/cm^2. Limited oxidation testing of Mo encapsulated with pure Ir indicates that the coating may offer protection to approximately 1,000°C in flowing air, but that at higher temperatures, the volatility of its oxide limits use of pure Ir. Alloy coatings of Ir with Pt, Pd, and Rh up to 4 mils thick were formed from a fused NaCN electrolyte; because their oxides are less volatile, these alloys may protect substrates at higher temperatures. Deposits made from aqueous electrolytes either had very low rates of deposition or were highly stressed and cracked when heavy deposits were made. (auth)

41543 (KFK-585) THE TECHNOLOGY OF UAl_3-Al IRRADIATION TEST PLATES. Nazare, S.; Ondracek, G.; Thuemmler, F. (Kernforschungszentrum, Karlsruhe (West Germany). Institute fuer Material- und Festkoerperforschung). Apr. 1967. 50p. Dep.

The preparation of UAl_3 dispersions in Al for use as fuel material in high flux reactors is discussed. Preparation of the UAl_3 is discussed; production of UAl_3-Al pellets is outlined. The structure and properties of UAl_3-Al dispersions is discussed briefly. 38 references. (M.L.S.)

41544 (NLCO-997) URANIUM MACHINING. Stephens, W. E. (National Lead Co. of Ohio, Cincinnati). May 2, 1967. Contract AT(30-1)-1156. 19p. (CONF-670432-1). Dep. CFSTI. From American Society of Tool and Manufacturing Engineer Conference, Chicago, Ill.

The equipment and procedures employed by the Feed Materials Production Center for the fabrication of metallic U fuel element cores are described. Some of the significant properties of U and safety precautions employed in machining operations are discussed. The special carbide cutting tools and cutting fluids are described, and tool life, U diffusion into tool tips, and turning and drilling procedures are summarized. 22 references. (H.D.R.)

41545 POROSITY IN WELD METAL DURING FUSION WELDING NIOBIUM ALLOYS. D'yachenko, V. V.; Ivanov, V. K.; Morozov, B. P.; Sivov, E. N. Svar. Proizv., No. 7, 10-13 (July 1967). (In Russian).

Studies of the nature and causes of porosity formation during Nb alloy fusion welding showed that the gases formed by oxygen and carbon reactions are the main causes of porosity in the welded seam. Impurities of oxides, grease, and adsorbed gases on the leading edge also influence considerably the formation of porosity. Cutting and etching of the material in the mixture of HF and HNO_3 followed by elution and drying helps to eliminate the porosity in the welded seam. (R.V.J.)

41546 STUDIES ON ALLOYS OF NOBLE METALS WITH ELECTROPOSITIVE ELEMENTS. XII. C II TYPE PHASES IN ALLOYS WITH RARE EARTHS. Ferro, Riccardo; Capelli, Renzo; Borsese, Aldo; Delfino, Stefano. Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur., 42: 60-4(Jan. 1967). (In Italian).

Several alloys of rare earths were prepared with Ag and Au. Results of chemical analysis, specific gravity determination, and micrographic and x-ray examinations are reported. The structural data are discussed. (auth)

41547 EXPERIMENT OF DIFFUSIVE WELDING OF HARD ALLOYS. Gerasimenko, K. S.; Spirina, S. I. (Kharkov Polytechnic Inst.). Porosh. Met., Akad. Nauk Ukr. SSR, No. 8, 1100-5(Aug. 1967). (In Russian).

Feasibility studies for obtaining a strong compound of some hard-alloyed parts by heating under pressure were carried out. Technology was developed for oversintering new layers of the hard Co-W alloy of considerable thickness on the sintered hard alloy. (auth)

41548 ACTIVATED SINTERING OF TUNGSTEN WITH NICKEL ACTIVATORS. Samsonov, G. V.; Yakovlev, V. I. (Inst. of Problems of Material Management, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR, No. 8, 10-16(Aug. 1967). (In Russian).

The dependence of various properties of W bars on the temperature of sintering, Ni content, and a method of nickel introduction into the pressing was studied. Compactness, strength, and microhardness of W bars increased over the range from 1000 to 2000°C as sintering temperature and Ni content in the pressings increased. Decrease of strengthening temperatures from 1600 to 1800°C is explained by intensive evaporation of Ni activator, exceeding the sintering rate with its activating participance. Growth rate of W grains increased with increasing temperature and nickel content. Method of nickel introduction did not affect W properties. Optimum content of the activating Ni was 0.5 vol %. It is assumed that an activating effect of Ni lies in transmission of the part of nonlocalizing electrons to W atoms. It results in a decrease of the energy reserve of the whole system and permits sintering at rather low temperatures, without excitation of the stable energy configuration formed by localized part of tungsten valence electrons. (auth)

41549 RETURN AND RECRYSTALLIZATION OF CERMET TUNGSTEN WITH SMALL ADDITIVES OF NICKEL. Panichkina, V. V.; Skorokhod, V. V. (Inst. of Problems of Material Management, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR, No. 8, 46-53 (Aug. 1967). (In Russian).

Changes in microstructure and submicrostructure during the sintering of compact samples and during the annealing of strained W samples with small additives of Ni and Pd were investigated. It is shown that a unipolar diffusion of W into Ni is, apparently, the reason of the activated sintering and accelerated growth of blocks of mosaic during the annealing after the strain, and as a result of this the redundant vacancies appear on the tungsten side. These vacancies provoke the replacement of dislocations in the material. (auth)

41550 DIFFUSION SILICONIZING AND ALUMINIZING OF Mo POWDERS. Gebalski, Stanislaw. Pr. Inst. Mech. Precyz., 9: 1-10(1961). (In Polish).

Diffusion siliconizing and aluminizing of Mo powders were studied with sintered Mo powders forged and annealed at 1200°C. Aluminizing and siliconizing took place in powder mixtures con-

taining 50 to 70% Si or Al, 50 to 30% kaolin, and 0 to 0.5% NH_4Cl. The Al and Si fractions were 0.15 to 0.12 mm dia and the kaolin 0.09 to 0.06 mm. (R.V.J.)

41551 PHASE EQUILIBRIA IN ALUMINIUM-RICH ALLOYS OF ALUMINIUM-GADOLINIUM AND ALUMINIUM-TERBIUM. Runnalls, O. J. C.; Boucher, R. R. (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Less-Common Metals, 13: 431-42 (1967).

The Al-rich compounds $GdAl_4$ and $TbAl_4$ precipitate in Al–Gd and Al–Tb alloys cast from the liquid and decompose by a peritectoid reaction at 400° and 420°C, respectively, to form α-Al plus $GdAl_3$ and $TbAl_3$. The latter compounds form eutectic mixtures with Al at approximately 10 wt. % Gd and Tb with melting points of 643° and 644°C, respectively. Thermal analysis and X-ray diffraction experiments indicate that a solid-state transformation possibly involving a rearrangement or clustering of vacancies is initiated on cooling $GdAl_3$ to 641°C and $TbAl_3$ to 642°C. $GdAl_4$ and $TbAl_4$ are isostructural with orthorhombic UAl_4. Both $GdAl_3$ and $TbAl_3$ have structures based on an assembly of close-packed layers containing a ratio of one lanthanide to three Al atoms in each layer. The stacking sequences of the layers are ABA... for $GdAl_3$ ($SnNi_3$ structure) and ABABCBCACA... for $TbAl_3$ (rhombohedral $PuAl_3$ structure). (auth)

41552 THE SOLID SOLUBILITY OF NITROGEN IN Nb AND Nb-RICH Nb–Hf, Nb–Mo, AND Nb–W ALLOYS. PART II. THE TERNARY SYSTEMS Nb–Hf–N, Nb–Mo–N, AND Nb–W–N. Taylor, A.; Doyle, N. J. (Westinghouse Research Labs., Pittsburgh). Contract AF 33(657)-11157. J. Less-Common Metals, 13: 413-30(1967).

Using a Sieverts apparatus and a combination of X-ray diffraction and microscopical methods, a survey has been made of the solid-solubility of N_2, as a function of pressure and temperature, in Nb-rich Nb–Hf, Nb–Mo and Nb–W alloys nitrided in the form of thin wires. In general, it can be stated that the presence of Hf, Mo or W markedly decreases the amount of N_2 which can be retained interstitially within the Nb lattice. Thus at 2000°C and 2.8×10^{-1} torr N_2 about 9.4 at. % N_2 is taken into solution by Nb. This falls to less than 1.0 at. % N_2 at 10.0 at. % Hf or Mo, and to about 6.8 at. % N_2 at 10.0 at. % W. (auth)

41553 THE SOLID SOLUBILITY OF NITROGEN IN Nb AND Nb-RICH Nb–Hf, Nb–Mo, AND Nb–W ALLOYS. PART I. THE BINARY SYSTEM Nb–N. Taylor, A.; Doyle, N. J. (Westinghouse Research Labs., Pittsburgh). Contract AF 33(657)-11157. J. Less-Common Metals, 13: 399-412(1967).

Using a dynamic leak method, a Sieverts apparatus and a combination of X-ray diffraction and microscopical techniques, a study has been made of the interstitial solid-solubility of N_2 in Nb as a function of pressure and temperature. It has been found that Nb can accommodate 9.48 at.% N interstitially at 2200°C and 3×10^{-1} torr N_2, but the amount which can be retained in solution at room temperature is very much smaller, being about 1.0 at.% depending on the quenching rate. The results are fully in accord with those of Gebhardt, Fromm and Jakob, and of Cost and Wert who obtain a relationship $x = 6.2 \times 10^{-4} (p_{N_2})^{\frac{1}{2}} \exp(46{,}000/RT)$ for the amount x, in at.% of nitrogen in solid solution, p_{N_2} being the nitrogen pressure in torr, R the gas constant and T in degrees Kelvin. The lattice parameter of Nb is increased for a = 3.2986 Å to 3.3060 Å with 1.05 at.% N retained in the lattice. (auth)

41554 OBTAINING SINGLE CRYSTALS OF REFRACTORY METALS BY THE CHOKHRALSKI METHOD. Sushkin, N. G.; Budzinskii, O. Z.; Efimov, V. E. Izv. Akad. Nauk SSSR, Metal., No. 3, 94-100(May-June 1967). (In Russian).

Single crystals of Nb and Mo (15 to 20 mm in diameter and 150 to 300 mm long) were obtained by the Chokhralski method in which the metals are melted by electron beam. Single crystals of Nb obtained with a pulling rate of 6.0 to 15.6 mm/min had a strength of 9.15 to 10.80 kg/mm^2 and an elongation of 24.8 to 41.4% as compared with Nb obtained by vacuum-arc melting, whose strength was 50 to 60 kg/mm^2 and elongation 10 to 15%. Lower strength and higher elongation indicate that Nb obtained by this method has less impurities and a more perfect structure than Nb obtained by other methods. Single crystals of Mo obtained with a pulling rate of 6.0 to 13.9 mm/min had a strength of 42.9 to 34.2 kg/mm^2, a yield strength of 28.4 to 34.1 kg/mm^2, an elongation of 32.6 to 33.8% and a reduction area of 37.4 to 53.4% as compared with Mo single crystals obtained by zone melting whose strength was 29 to 46 kg/mm^2, yield strength 15.6 to 22.5 kg/mm^2, elongation 23 to 31%, and reduction of area 47 to 100%. It can be seen that Mo single crystals obtained by the Chokhralski method have a higher yield strength, elongation and reduction of area than those obtained by zone melting. Decreasing the rate of Mo single crystal growth from 12 to 13 to 6 to 9 mm/min increased its strength. (ATD)

41555 ALUMINOTHERMIC REDUCTION OF TUNGSTIC OXIDE. Gupta, C. K.; Jena, P. K. (Bhabha Atomic Research Centre, Trombay, India). J. Less-Common Metals, 13: 269-73 (Sept. 1967).

Massive W metal was prepared by the aluminothermic reduction of WO_3. Small amounts of Ca and S were added to the Al–WO_3 mix to trigger the reaction. Experimental procedures are described as are physical properties of the product. (P.G.C.)

41556 ELECTROPLATING ^{60}Co WITHOUT RESIDUE. Christensen, Carl J.; Jacobsen, Andrew T. (Univ. of Utah, Salt Lake City). Bull. Utah Eng. Exp. Sta., No. 139, 1-14(June 1966).

Several tons of 1/8-in. dia magnetic pellets with uniformly contained ^{60}Co at a level of 1.0 ± 0.2 Ci/lb were prepared and, for protection, plated with Ni followed by a layer of Cd. A barrel plating operation was developed. The Co electrolyte was a solution of $CoSO_4$ at pH = 3.5 and sufficiently acid to dissolve iron readily from the uncoated iron pellets. To keep the $Fe(OH)_2$ in the electrolyte low and to promote adhesion of the Co plate, the Fe pellets were first plated with a 0.25-mil Cu layer before being plated with Co. The operation was devised for a hot cell. An inert Pb anode was used and the electrolyte was continuously replenished with Co from a $CoCO_3$ slurry. All the ^{60}Co can be plated out with substantially no radioactive scrap. (M.C.G.)

41557 CONTACT BUTT WELDING OF MOLYBDENUM WITH ARMCO IRON. Chenguraev, L. I. Svar. Proizv., No. 8, 30-1(Aug. 1967). (In Russian).

Favorable results of contact butt welding of Mo to Armco iron in an MC-3 machine are described. In order to obtain strong ductile compounds and secure optimum heating conditions the diameter of the Armco iron billet should be about 10% larger than the diameter of the Mo billet prepared for the welding. (R.V.J.)

41558 WELDED, COLD-DRAWN, TUBES OF HIGH-GRADE STEEL IN REACTOR CONSTRUCTION. Pappert, W. (Deutsche Gilby-Fodor GmbH, Langenfeld, Ger.). Atomwirt. Atomtech., 12: 363-5(July 1967). (In German).

The manufacturing process and technical features of the welded, multiple cold-drawn tube of high-grade steel are described. Welding is carried out by the WIG process in which a protective gas is fed to the external and internal welds of the tube. The starting material is a high-grade steel tape rolled on a Sendzimir mill, which shows close and uniform tolerances over its whole cross section. The high quality of tape rolled in this way is transferred to the tube. The thickness of the tape is limited. The welding speed decisively determines the quality of the welded seam. Continuous improvements over the last few years ensure that the tubes after welding show a completely smooth surface. Usually two drawing operations are sufficient for tubes on which no unusual demands are placed. The number of drawing operations for tubes having extremely thin wall thicknesses is far greater. Corrosion resistance is considerably enhanced by the particularly smooth inside surface of the tubes and hence the risk of contamination of the system is very much reduced. A table shows the dimensions of tubes with extremely thin wall thicknesses that were made using this process. A further table summarises the essential and prescribed tests for monitoring the individual manufacturing stages. (auth)

41559 ZINC ALLOYS CONTAINING BERYLLIUM. Kwiecien, Witold; Kaczmarczyk, Aniela; Zlobinska, Krystyna. Rudy Metale Niezelaz., 12: 305-9(June 1967). (In Polish).

The properties and application of Be to the production of Zn photoengraving plates are discussed. Investigations were carried out to determine the most favorable composition of the Zn–Al–Be master alloy for a rational production of photoengraving plates. Optimum results were obtained with a master alloy containing 1.25% Be, 12.5% Al, and the rest Zn. An alloy of such a composition enables the manufacture of photoengraving plates containing 0.003 to 0.005% Be. (auth)

41560 METHOD OF GROWTH OF PERFECT CRYSTALS OF α-URANIUM BY HOT PLASTIC DEFORMATION AND ANNEALING AT HIGHER TEMPERATURE IN THE α PHASE. Jean-Louis, Francois; Daniel, John S.; Lacombe, Paul (Ecole des Mines, Paris). Compt. Rend., Ser. C, 264: 1818-21(June 5, 1967). (In French).

The method of critical hammer hardening followed by annealing at high temperature without intermediate cooling to 20°C avoids the development of twin crystals and makes it possible to obtain perfect grains of alpha–U with lengths between 5 and 15 mm. The critical deformation of the order from 2.1 to 2.5% was made near 360°C at a rate of 6.6%/min. This was followed immediately by a temperature rise at the rate of 50°C/hr up to 655°C. The sample

was maintained at this temperature for two hours and then cooled at a rate of 100°C/hr. The parameters with a determining effect on the perfection of the crystals were the U purity, grain size, texture, temperature, rate and degree of transformation, and temperature and duration of annealing. (J.S.R.)

41561 INTRODUCTION TO TECHNICAL CERAMICS. Waye, B. E. London, McClaren and Sons, 1967. 191p. 48s.

The subject is treated under the following headings: Introduction; raw materials (including zirconium compounds); manufacture–general and body preparation; manufacture–plastic shaping methods; manufacture–non-plastic shaping methods; manufacture–glazing, firing, inspection; porcelain–compositions, processing, properties; porcelain–products, modified compositions; high temperature ceramics–properties, fabrication methods; high temperature ceramics–oxides (including BeO, Al_2O_3, ZrO_2, ThO_2, UO_2); high temperature ceramics–non-oxides (including carbon and graphite, borides, B_4C, SiC, ZrC, UC, UN); high temperature ceramics–various products and applications (including cermets, nuclear energy materials, materials for MHD generators); high frequency ceramics–steatite; high frequency ceramics–high permittivity dielectrics; high frequency ceramics–magnetic ceramics (ferrites); metallized ceramics. (UK)

41562 DEGASSING REACTIONS IN MELTING AND ANNEALING NIOBIUM AND TANTALUM IN HIGH VACUUM. Gebhardt, E.; Fromm, E. (Max-Planck-Institut fuer Metallforschung, Stuttgart). 32p. (In German). (CONF-650939–5). DTIE.

From 2nd International Symposium on Hyperpure Products in Science and Technology, Dresden.

Reactions during the degassing process were quantitatively studied in the solid state for Nb–N, Nb–O, Ta–O, and Ta–N systems. The results are based on kinetic measurements, equilibrium studies, and steady-state experiments. The starting material for the experiments consisted of a solid solution of gas in solid metal as well as specimens with oxide and nitride surface layers. The results showed that N_2 is degassed in the form of N_2 molecules, whereas O_2 escapes from the metal in the form of volatile oxides. Some quantitative equations were derived that give the relationship between the maximum N_2 and O_2 content as a function of the annealing temperatures and the partial pressure of N_2 or O_2 and water vapor in the recipient. Experiments with the Ta systems showed that the degassing reactions that take place in the liquid state are the same as those in the solid state. (auth)

41563 ELECTRON ZONE MELTING OF TUNGSTEN AND MOLYBDENUM. Barthel, J.; Petri, R. (Institut fuer Metallphysik und Reinstmetalle, Dresden). 17p. (In German). (CONF-650939–3). DTIE.

From 2nd International Symposium on Hyperpure Products in Science and Technology, Dresden.

A survey is given of some results and some open questions concerning electron-beam zone melting of W and Mo. In particular the melting behavior of different raw materials and their influence on the purity of the grown crystals are discussed as well as crystal growth, distribution of impurities, process of purification, and attainable purity depending on the melting conditions. (auth)

41564 PERSPECTIVES IN POWDER METALLURGY. FUNDAMENTALS, METHODS, AND APPLICATIONS. VOLUME 1. NEW METHODS FOR THE CONSOLIDATION OF METAL POWDERS. Hausner, Henry H.; Roll, Kempton H.; Johnson, Peter K. (eds.). New York, Plenum Press, 1967. 263p. $15.00.

Abstracts were prepared for 10 chapters on compaction of metals, alloys, and composites. The remaining 4 chapters deal with explosive compaction, powder rolling, and hydrostatic extrusion. (P.C.S.)

For abstracts of individual chapters see: 41565–41573 and 41582.

41565 ISOSTATIC PRESSING OF POWDERED MATERIALS. Jackson, Harry C. (National Forge Co., Irvine, Pa.). pp 13–26 of Perspectives in Powder Metallurgy. Fundamentals, Methods, and Applications. Volume 1. New Methods for the Consolidation of Metal Powders. Hausner, Henry H.; Roll, Kempton H.; Johnson, Peter K. (eds.). New York, Plenum Press, 1967.

The future of isostatic pressing is discussed along with its advantages, applications, safety aspects, and equipment demands. (P.C.S.)

41566 HYDROSTATIC PRESSING OF POWDERS. van Buren, Charles E.; Hirsch, Harold H. (General Electric Research Lab., Schenectady, N. Y.). pp 27–64 of Perspectives in Powder Metallurgy. Fundamentals, Methods, and Applications. Volume 1. New Methods for the Consolidation of Metal Powders. Hausner, Henry H.; Roll, Kempton H.; Johnson, Peter K. (eds.). New York, Plenum Press, 1967.

Pressure, particle hardness, size distribution, and granulations were investigated to establish their effects on the quality of the pressed bodies and their subsequent processing. Isostatic pressing produced compacts with improved mechanical properties versus die pressing. (P.C.S.)

41567 CONSOLIDATING METAL POWDERS MAGNETICALLY. Sandstrom, Donald J. (Los Alamos Scientific Lab., N. Mex.). pp 75–81 of Perspectives in Powder Metallurgy. Fundamentals, Methods, and Applications. Volume 1. New Methods for the Consolidation of Metal Powders. Hausner, Henry H.; Roll, Kempton H.; Johnson, Peter K. (eds.). New York, Plenum Press, 1967.

A technique was devised for consolidating refractory metal powders into tubular shapes by using opposing magnetic fields in a coaxial conductor. Tubes of W, Mo, W + UO_2, and Mo + UO_2 powders were compacted without binders. In every instance green density and strength of the tubes was high enough to allow handling with ease even before sintering. (P.C.S.)

41568 NEW METHOD FOR COMPACTING METAL OR CERAMIC POWDERS INTO CONTINUOUS SECTIONS. Emley, Frank; Deibel, Charles (Westinghouse Electric Corp., East Pittsburgh, Pa.). pp 83–97 of Perspectives in Powder Metallurgy. Fundamentals, Methods, and Applications. Volume 1. New Methods for the Consolidation of Metal Powders. Hausner, Henry H.; Roll, Kempton H.; Johnson, Peter K. (eds.). New York, Plenum Press, 1967.

A technique for pressing powders into continuous bars, applicable to many different metals and alloys, ceramics, and combinations of these, is described in detail and lab set-up is shown. Experiments indicate it will provide an excellent method economically and technically, in comparison to other fabricating methods. Relatively-inexpensive, readily-available equipment can permit experimentation, development, and small-scale production of limited-length bars from powder, granular, or sponge raw materials. Applications are given for Be, Mo, W, Ta, and other refractory materials. (P.C.S.)

41569 MECHANISM OF THE COMPACTION OF METAL POWDERS BY ROLLING. Evans, P. E. (Manchester Coll. of Science and Tech., Eng.). pp 99–118 of Perspectives in Powder Metallurgy. Fundamentals, Methods, and Applications. Volume 1. New Methods for the Consolidation of Metal Powders. Hausner, Henry H.; Roll, Kempton H.; Johnson, Peter K. (eds.). New York, Plenum Press, 1967.

A short review of powder rolling is followed by description of some experiments on the rolling of Cu powder. Factors such as rolling mill, powder size and particle shape, and sintering variables are taken into account. Theoretical aspects are discussed with experiments performed successfully on Fe, Ni, Cu, Ti, Ta, and stainless steel powders; mixtures of Fe–Cu, Fe–Cr, Cu–Sn, Cu–Pb, and Ag–Ni; and metal and oxide mixtures such as Cu–Al_2O_3. A mechanism of compaction is offered. (P.C.S.)

41570 EXTRUSION OF METAL POWDERS. Gardner, Norman R.; Donaldson, Allan D.; Yans, Frank M. pp 169–80 of Perspectives in Powder Metallurgy. Fundamentals, Methods, and Applications. Volume 1. New Methods for the Consolidation of Metal Powders. Hausner, Henry H.; Roll, Kempton H.; Johnson, Peter K. (eds.). New York, Plenum Press, 1967.

Economic and technical aspects of extrusion of metal powders are discussed. Be, Mo, W, dispersion-hardened alloys, and Ni-base super alloys are considered. (P.C.S.)

41571 BERYLLIUM POWDER FORGING. Orrell, N. G. (Wyman-Gordon Co., Worcester, Mass.). pp 203–20 of Perspectives in Powder Metallurgy. Fundamentals, Methods, and Applications. Volume 1. New Methods for the Consolidation of Metal Powders. Hausner, Henry H.; Roll, Kempton H.; Johnson, Peter K. (eds.). New York, Plenum Press, 1967.

Metallurgical problems encountered in fabrication of Be are discussed. Data sheets are included to illustrate the mechanical properties obtained on various shapes and sizes of Be under varying conditions. (P.C.S.)

41572 SLIP CASTING OF METAL POWDERS. Hausner, Henry H. (Polytechnic Inst. of Brooklyn). pp 221–38 of Perspectives in Powder Metallurgy. Fundamentals, Methods, and Applications. Volume 1. New Methods for the Consolidation of Metal Powders. Hausner, Henry H.; Roll, Kempton H.; Johnson, Peter K. (eds.). New York, Plenum Press, 1967.

Experiments were made with slip-cast and sintered stainless steel–Al_2O_3 and stainless steel–UO_2 compositions to determine

the value of slip casting in powder metallurgy. Slip-cast and sintered stainless steel, mixed with approximately 25 wt % UO_2, showed an elongation of more than 8%. What was shown for stainless steel was also found true for W, Mo, Co, and other steel powders. Advantages of slip casting in powder metallurgy are discussed. (P.C.S.)

41573 VIBRATORY COMPACTING OF METAL POWDERS. Brackpool, J. L.; Phelps, L. A. (BSA Group Research Center, Birmingham, Eng.). pp 239-55 of Perspectives in Powder Metallurgy. Fundamentals, Methods, and Applications. Volume 1. New Methods for the Consolidation of Metal Powders. Hausner, Henry H.; Roll, Kempton H.; Johnson, Peter K. (eds.). New York, Plenum Press, 1967.

Experiments were carried out to assess the effect of vibratory-compacting on the segregation of particles of widely differing densities. Several mixtures of Cu and W powders of similar particle-size ranges were compacted under various conditions and were examined metallographically to show the distribution of W particles. Little or no segregation was found. The majority of the W particles were completely surrounded by Cu, voids being present only in the Cu matrix. Results showed this method of compaction could be used advantageously in production of compact intermetallic and nonmetallics in a ductile matrix, e.g., in the fabrication of both dispersion-strengthened alloys and superconducting alloys. (P.C.S.)

Properties Evaluations

Refer also to abstracts 40957, 41552, 41650, and 42163.

41574 (66-C-314) CHEMISORPTION AND OXIDATION: OXYGEN ON TUNGSTEN. McCarroll, Bruce (General Electric Co., Schenectady, N. Y. Research and Development Center). Sept. 1966. 14p.

Oxygen chemisorption and the extent of oxidation on a W ribbon at room temperature were studied by flash desorption using line-of-sight detection with a time-of-flight mass spectrometer. The only chemical species in the adlayer were oxygen atoms and the monotungstic oxides: WO, WO_2, and WO_3. These oxides were desorbed with an energy of ~100 kcal. In agreement with earlier predictions, O desorbed as atoms. Neither molecular O_2 nor polytungstic oxides were ever observed from a ribbon flashed after a room-temperature exposure to O_2. However, flowing O_2 on W at surface temperatures >1400°K produced the polytungstic oxides. An order of magnitude estimate of the adlayer composition at room temperature suggested that at saturation there is approximately one monolayer of atoms in a random configuration with a few tenths of a per cent each of the monotungstic oxides. Consequently, oxidation is not a significant surface process on clean W at room temperature. (auth)

41575 (IS-1600, Paper 5) METALLURGY DIVISION. Spedding, F. H.; Smith, J. F.; Bailey, D. M.; (and others) (Ames Lab., Iowa). 87p.

Developments are reported for studies on: metal preparation and purification for fuels and cladding; phase relations in reactor materials; reactor materials development; crystal plasticity; imperfection structure and relation to properties; phase formation, structure and stability of materials; thermodynamic properties and phase relations; diffusion and transport properties; radiation damage; and materials preparation and characterization. (P.C.H.)

41576 (LA-3742) THE SOLUBILITIES OF SELECTED ELEMENTS IN LIQUID PLUTONIUM. XI. ZIRCONIUM. Bowersox, D. F.; Leary, J. A. (Los Alamos Scientific Lab., N. Mex.). July 5, 1967. Contract W-7405-eng-36. 5p. Dep. CFSTI.

The solubility of Zr in liquid Pu was measured from 700 to 950°C under reversible conditions. The solubility increased from 0.81 wt % Zr at 700°C to 7.6% Zr at 950°C. The data fit the empirical equation, $\log N_{Zr} = 2.86 - 4.42 \times 10^3\ T^{-1}$, where N_{Zr} is the mole fraction of Zr in solution and T is the temperature in degrees Kelvin. (auth)

41577 (UCID-15170) PROPERTIES OF MULBERRY. Weiss, H. D. (California Univ., Livermore. Lawrence Radiation Lab.). July 28, 1967. Contract W-7405-eng-48. 26p. Dep. CFSTI.

Mulberry, a metastable gamma-phase U-Nb-Zr alloy, is described. Physical properties are given; mechanical properties are detailed. Metallurgical characteristics are tabulated. 18 references. (M.L.S.)

41578 (USBM-RC-1297) PRELIMINARY EVALUATION OF PRE-ALLOYED TUNGSTEN-25 RHENIUM POWDERS. Topical Report, July 1, 1965-June 30, 1966. Asai, Gene; Kato, Haruo (Bureau of Mines, Albany, Oreg. Albany Metallurgy Research Center). June 1967. Contract AT(11-1)-599. 34p. Dep. CFSTI.

Co-reduced W-25Re powders prepared at three locations and determination of their suitability for use in the preparation of sintered sleeve extrusion blanks are investigated. The particle size and particle size distribution of the as-received powders are determined. The powders were analyzed by x-ray diffraction, electron microprobe, chemical, and spectrographic methods. Sintering tests were made in the temperature range of 1,500° to 2,400°C. Limited extrusion tests were made for each material. Results are presented. (auth)

41579 (WERL-2823-27) PERMEATION OF HYDROGEN THROUGH TUNGSTEN AND MOLYBDENUM. Frauenfelder, R. (Westinghouse Research Labs., Pittsburgh, Pa.). June 23, 1967. Contract AT(30-1)-2823. 43p. Dep. CFSTI.

Using ultrahigh vacuum- and mass spectroscopic techniques, permeation of H_2 through wrought- and vapor-deposited W tubes and through a drawn Mo tube was measured for pressures between 10^{-6} and 200 Torr and temperatures from 1050 to 2400°K. The permeation rates varied with pressure and temperature in a complex manner. Analytical expressions for the permeation rate are derived which are based on the assumptions that the rate determining step of the permeation process is diffusion of H_2 in the bulk of the sample and the rate of desorption of H_2 atoms, the rate of recombinative desorption of H_2 molecules, and the concentration of dissolved H_2 atoms are each determined by the concentration of H_2 atoms adsorbed on the surface of the permeation sample. For the H_2-W system, this analysis is in agreement with the measured rates over the entire range of temperature and pressure, and the experimental data are consistent with Hickmott's values for: the rate of desorption of H_2 atoms; the rate of recombinative desorption of H_2 molecules; the sticking probability for H_2 atoms; and the probability that a H_2 molecule hitting the surface is dissociated and adsorbed as two atoms. For the H_2-Mo system, permeation is controlled by phase-boundary processes at low driving pressures. Measured values for the permeation constants are in agreement with the equation $P = P_0 \exp(-Q_P/RT)$ for pressures ≥ 1 Torr. The results $P_0 = (1.5 \pm 0.5) \times 10^{-3}$ Torr l/cm sec Torr$^{-\frac{1}{2}}$ and $Q_P = (31.5 \pm 1)$ kcal/mole were found for W. For Mo, the corresponding numbers are $(7.1 \pm 2) \times 10^{-4}$ and (21.5 ± 1). (auth)

41580 (WERL-2823-28) PERMEATION, DIFFUSION, AND SOLUTION OF NITROGEN IN TUNGSTEN AND MOLYBDENUM. Frauenfelder, R. (Westinghouse Research Labs., Pittsburgh, Pa.). June 30, 1967. Contract AT(30-1)-2823. 27p. Dep. CFSTI.

Using ultrahigh vacuum- and mass spectroscopic techniques, permeation, diffusion, and solution of N_2 in W and Mo were measured for pressures between 5×10^{-5} and 500 Torr and for temperatures between 1100 and 2500°K. The following values for the permeation constants, P (Torr l/cm sec Torr$^{-\frac{1}{2}}$), diffusion constants D (cm^2/sec), and solubility constants, S (Torr l/cm^3 Torr$^{-\frac{1}{2}}$), were obtained: $P(W) = 1.6 \times 10^{-4} \exp(-52000/RT)$; $P(Mo) = 6.1 \times 10^{-3} \exp(-47500/RT)$; $D(W) = 5.4 \exp(-62000/RT)$; $D(Mo) = 2.3 \times 10^{-2} \exp(-33000/RT)$; $S(W) = 3.0 \times 10^{-5} \exp(+10000/RT)$; and $S(Mo) = 2.6 \times 10^{-1} \exp(-14500/RT)$. For N_2 in Mo, the value found for the frequency factor of the diffusion constant is in agreement with Zener's theory of interstitial atomic diffusion. For N_2 in W, the values found for both the frequency factor of the diffusion constant and the diffusion activation energy are abnormally high and not in agreement with Zener's theory. The results obtained for the solubility constants are critically compared with previously published data. (auth)

41581 (LA-tr-67-67) INTERACTION OF METALLIC URANIUM WITH HYDROGEN. Galkin, N. P.; Sudarikov, B. N.; Shishkov, Iu. D.; Tarasov, V. I. Translated by Helen J. Dahlby (Los Alamos Scientific Lab., N. Mex.), from Tr. Mosk. Khim.-Tekhnol. Inst., No. 43, 67-71(1963). 10p. Dep. CFSTI. JCL $1,60 fs, $0,80 mf.

The reaction kinetics for the interaction of compact metallic U with H_2 under conditions of constant restoration of the surface of the metal were studied. The energy of activation of the hydridation of metallic U and the order of the reaction with regard to H_2 were determined. A kinetic equation was proposed for calculating the rate of the reaction as a function of the temperature and partial pressure of H_2. (J.C.W.)

41582 HOT-EXTRUDED CHROMIUM COMPOSITE POWDER. Watkins, R. V.; Reed, G. C.; Schalliol, W. L. (Bendix Products, South Bend, Ind.). pp 181-94 of Perspectives in Powder Metallurgy. Fundamentals, Methods, and Applications. Volume 1. New Methods for the Consolidation of Metal Powders. Hausner, Henry H.; Roll, Kempton H.; Johnson, Peter K. (eds.). New York, Plenum Press, 1967.

Hot extrusion of Cr-MgO, Cr-Nb-MgO, and Cr followed by sintering was considered for producing rods. Machinability for the Cr bars was poor, excellent for the Cr-MgO composite, and

good for Cr–MgO–Nb. Loss in density observed with increasing sintering temperature was attributed to internal gas evolution in the pure Cr and the Cr–MgO composite. In the Cr–Nb–MgO composite, the Kirkendall effect supplements this action. (P.C.S.)

41583 PRECIPITATIONS IN Ta–Cr SOLID SOLUTIONS. Gebhardt, Erich; Rexer, Juergen (Max-Planck-Institut fuer Metallforschung, Stuttgart). Z. Metallk., 58: 611-16(Sept. 1967). (In German).

The precipitation of $TaCr_2$ from supersaturated Ta–Cr solid solutions is continuous. In the temperature range from 1200 to 1450°C cellular precipitation occurs. The volume amount of this kind of precipitation diminishes with larger quenching rate because increasing vacancy density favors continuous precipitation. Cellular precipitation originates at the grain boundaries and does not depend on annealing time and temperature. The continuous precipitation proceeds at temperatures below 1200°C in two stages, which are accompanied by changes in hardness, electrical conductivity, and microstructure. The precipitation reaction rate in the second stage is very slow so that equilibrium can be obtained only after prolonged annealing times. (auth)

41584 MECHANICAL PROPERTIES OF Nb–Zr SOLID-SOLUTION ALLOYS. Yajima, Masami; Ishii, Mitsuru (Hitachi Ltd., Tokyo). Nippon Kinzoku Gakkaishi, 31: 664-8(1967). (In Japanese).

Tensile properties of Nb–Zr solid-solution alloys composed of the retained high-temperature β phase were investigated at temperatures from –196 to +800°C. The room-temperature yield stress increased linearly with the Zr content up to 15 at. % and reaches a maximum value of about 100 kg/mm² at 42 at. % Zr. The mechanical behavior of Nb–15 at. % Zr alloy was found to be similar to that of pure Nb, but the alloys with higher Zr content, e.g., 26 and 42 at. %, showed a different behavior from pure Nb. Nb–26 or 42 at. % Zr alloy did not show a sharp yield drop. The work hardening rate of the same alloy was smaller than that of Nb, being insensitive to the test temperature. Nb–26 or 42 at. % Zr underwent twin deformation below –72°C, and a distinct serration appeared in its load vs elongation curves. The low-temperature flow stress of these alloys increased significantly with decreasing temperature. The temperature dependence of flow stress of Nb–15 at. % Zr was similar to that of Nb whereas that of Nb–26 or 42 at. % Zr alloy was small compared with that of Nb and Nb–15 at. % Zr alloy. At temperatures above room temperature, the flow stress of Nb was insensitive to the test temperature and kept constant up to 600°C, while the flow stress of alloys decreased with temperature and became constant at some higher temperatures. The higher the alloy content, the greater was the decreasing rate. The temperature at which the flow stress becomes insensitive to temperature also rose with alloy content. Elongation at room temperature decreased with Zr content. But at high temperature, the effect of Zr content disappeared due to the large decrease of elongation of Nb. At temperatures above 600°C the elongation of Nb increased with temperature, while that of alloys continued to decrease with temperature. (auth)

41585 STRENGTH OF TUNGSTEN-FIBER-REINFORCED ALUMINUM COMPOSITES AT HIGH TEMPERATURES. Miura, Ishi; Honma, Hisao (Tokyo Medical and Dental Univ.). Nippon Kinzoku Gakkaishi, 31: 607-10(1967). (In Japanese).

Tensile and creep tests were carried out on Al composites containing continuous or discontinuous W fiber at high temperatures up to 545°C. The specimens containing continuous W fiber (10 and 20 vol %) showed very large values of tensile strength at 300 and 500°C; however the specific strengthening effects of the discontinuous-W-fiber-reinforced Al composites were considerably smaller than that of the fiber itself. The minimum creep rate of the composite containing 20 vol % continuous W fiber was estimated at about 10^{-4} to 10^{-5}%/hr under a load of 6.06 kg/mm² at 350°C, and the minimum creep rate-temperature curves on the discontinuous fiber were determined under a load of 1.43 to 3.05 kg/mm². By these results, for example, the minimum creep rate for the matrix was 6.0×10^{-2}%/hr under a load of 2.00 kg/mm² at 350°C; however the minimum creep rate for the composite containing 15 vol % discontinuous W fiber (diameter = 25μ) was 1.4×10^{-3}%/hr under the same condition. (auth)

41586 ADHERENCE AND POROSITY IN ION PLATED GOLD. Schroeder, C. F.; McDonald, J. E. (Sandia Corp., Albuquerque, N. Mex.). J. Electrochem. Soc., 114: 889-92(Sept. 1967).

The accelerated ion deposition process is shown to provide Au films and coatings, which are strongly adherent even when deposited on oxidized Be–Cu substrates. The porosity of these coatings when deposited under conditions that provide high substrate surface temperature is undetectable at thicknesses of approximately 2 μ and is the result of the formation of a Au–Cu solid solution. (auth)

41587 DEFORMATION OF PASSIVE FILMS. Bubar, S. F.; Vermilyea, D. A. (General Electric Research and Development Center, Schenectady, N. Y.). J. Electrochem. Soc., 114: 882-5 (Sept. 1967).

An estimate of the ductility of a passive film can be made by straining the metal covered by the film and observing the current required to keep the film at its normal thickness. For the metals tested, the relative ductilities of passive films as measured by this technique decreased in the order Ta; 16 Cr–14 Ni–bal. Fe; type 304 stainless steel; Fe; Al; 60 Ni–16 Cr–bal. Fe; Zr; and 80 Ni–20 Cr. (auth)

41588 THE THERMAL TEST CENTER AT GRAND-QUEVILLY. Villiers; Andro (la Societe Stein et Roubaix). Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.), No. 65, 63-72(1967). (In French).

The assembly constructed for study of the heat-transfer characteristics of liquid metals is described. The steam generator, Na heater, intermediate exchanger, primary Na loop, secondary NaK loop, water vapor loop, Ar circuit, safety and control, and regulation are described. The measurements made with this assembly include temperature measurements, pressure measurements, output measurements, measurement of the quality of water, and H_2 measurements. (J.S.R.)

41589 ELASTIC MODULI AND DEBYE TEMPERATURES OF THE POLYCRYSTALLINE RARE-EARTH METALS AT 4.2 AND 300°K. Rosen, M. (Atomic Energy Commission, Negev, Israel). Phys. Rev. Lett., 19: 695-6(Sept. 18, 1967).

The polycrystalline values of the Young's and shear moduli, the adiabatic compressibility, Poisson's ratio, and the Debye temperatures at 4.2 and 300°K for the rare earth metals are reported. Although the values of the elastic properties at 42 and 300°K are close to each other, the moduli and Debye temperatures varied at temperatures between those listed. Sharp peaks in the adiabatic compressibility appeared at the magnetic transition temperatures. The elastic moduli at 4.2°K increased with increasing atomic number with the exception of Eu and Yb. (A.G.W.)

41590 MECHANICAL PROPERTIES AND STRUCTURE OF SINTERED MOLYBDENUM SHEETS USED FOR DEEP DRAWING. Mutovin, V. D.; Osipov, V. G. Kuznechno-Shtampovochnoe Proizvod., No. 9, 24-5(1966).

A series of experiments was conducted to determine the effects of heat treatment on the mechanical properties and deep drawing characteristics of sintered molybdenum sheets. Specimens, 0.5 mm thick and 5 mm wide, annealed at temperatures ranging from 800 to 1600°C, were first subjected to tensile tests. It was found that the strength and hardness of molybdenum steadily decreased with increased annealing temperature. Elongation first increased, reached a maximum with an annealing temperature of 1300°C, and then dropped sharply. To determine the effects of heat treatment on the formability of molybdenum in deep drawing, the specimens annealed at temperatures from 800 to 1600°C were deep drawn through a die 20 mm in diameter. The formability was evaluated from the coefficient of reduction K_g = D max/d, where D is the largest blank diameter to withstand deep drawing without cracks and d is the cup diameter. The maximum K_g was obtained in specimens annealed at 900°C. The formability of sintered molybdenum was found to increase with decreasing deformation rate. (ATD)

41591 COMPOSITE MATERIALS AND THEIR APPLICATION FOR ELECTRICAL CONTACTS. Schreiner, Horst (Siemens AG, Nuremburg). Z. Metallk., 58: 600-5(Sept. 1967). (In German).

The composite materials for electrical contacts are based on the systems metal/metal, metal/intermetallic compound, and metal/metaloid. Of the systems metal/metal, the most important dispersion composites are represented by Ag–Ni alloys containing 10 to 40 wt % Ni and Ag–W alloys containing 10 to 90 wt % W and the most important infiltrated composites are represented by Cu–W alloys containing 50 to 80 wt % W. Of the systems metal/intermetallic compound the dispersion composites Ag–CdO containing 5 to 15 wt % CdO, and Ag–WC containing 60 to 80 wt % WC are discussed. Of the systems metal/metaloid the glide constants Cu–graphite and the point contacts Ag–graphite containing up to 10 wt % C are mentioned. Beyond the production procedures the properties of these composite materials and their applications are described. (auth)

41592 THE OXIDATION OF URANIUM–TITANIUM ALLOYS IN CARBON DIOXIDE AT 450°C. Gerrish, M. E.; Stobbs, J. J. (Central Electricity Generating Board, Berkeley, Eng.). J. Inst. Metals, 95: 284-6(Sept. 1967).

Alloy samples containing 0.9, 3.6, 8.1 and 18.8 at.% Ti were annealed at 1000°C, and oxidation kinetics were measured on a microbalance at 450°C in CO_2 at 100 mm pressure. The early

stages of oxidation were also studied metallographically. The results, which are presented graphically, show that although the oxidation rate of U_2Ti is low, the presence of U_2Ti precipitates in dilute alloys containing greater than about 4 at. % Ti leads to a significant increase in the rate compared with that of U. Localized oxidation occurs at the precipitate/matrix interface, and the rate increases with Ti content up to at least 19 at. %. (UK)

41593 SURFACE TENSION OF THE ALKALI METALS. Bohdansky, J.; Schins, H. E. J. (CCR–Euratom, Ispra, Italy). J. Inorg. Nucl. Chem., 29: 2173-9(Sept. 1967).

The surface tension of the alkali metals was measured at high temperature, using the maximum bubble pressure method in an open heat-pipe. The investigated temperature range was between 1200°K and 1600°K for Li and between 700°K and 1200°K for the other metals. The experimental results are compared with existing experimental and theoretical data. (auth)

41594 TEMPERATURE DEPENDENCE OF YOUNG'S MODULUS AND INTERNAL FRICTION OF A TWO-PHASE ZIRCONIUM–HYDROGEN ALLOY. Brown, H. L.; Armstrong, P. E.; Kempter, C. P. (Los Alamos Scientific Lab., N. Mex.). J. Less-Common Metals, 13: 373-7(1967).

Thermal expansion and dynamic Young's modulus of a two-phase ($\delta + \gamma$) ZrH, containing 53.6 at. % (1.26 wt %) H, were determined from 20° to 410°C. Young's modulus at 20°C was 13.7×10^6 psi, decreasing non-uniformly to 13.2×10^6 psi at 410°C. The average linear thermal expansion coefficient was 8.9×10^{-6}/°C for the temperature range 20°–400°C. The average bulk density was 5.87 g/cm^3 at 20°C. The shear modulus was 5.31×10^6 psi at 20°C. Internal friction values are reported from 20° to 225°C. Room temperature data for a two-phase ($\delta + \gamma$) alloy containing 55.3 at. % (1.35 wt. %) H are compared. (auth)

41595 PRE-MELTING PHENOMENON IN SODIUM-POTASSIUM ALLOYS. Woodruff, D. P.; Forty, A. J. Phil. Mag., 15: 985-93(May 1967).

A study of melting in K-rich Na–K alloys was made by direct observation using the technique of transmission ultra-violet microscopy. In this way it was possible to observe pre-melting of grain boundaries and certain other pre-determined sites in the solid metal. At high rates of melting, a microstructure of diluted alloy and molten strips of metals were observed ahead of the main advancing melting front. This is explained in terms of an instability arising from the local diffusion of Na from the solid into the liquid phase, resulting in a form of constitutional superheating. There is an analogy between this and constitutional supercooling which occurs in solidification and leads to the well-known cellular structure of the solid/liquid interface. However, unlike this latter effect, in constitutional superheating the instability does not occur in the immediate vicinity of the interface but only in the solid metal ahead of it. This can be explained if the solidus temperature distribution ahead of the advancing interface is significantly different in form from that of the liquidus in the solidifying melt. If the instability occurs generally in the melting of binary alloys it could lead to a significant change in the present concept of rate-controlling processes in melting. (auth) (UK)

41596 KNUDSEN CELL STUDIES OF THE VAPORIZATION OF GADOLINIUM AND GADOLINIUM DICARBIDE. Hoenig, Clarence L.; Stout, Norman D.; Nordine, Paul C. (Univ. of California, Livermore). J. Amer. Ceram. Soc., 50: 385-91 (Aug. 21, 1967). (UCRL–70092).

Vapor pressure of Gd metal and C-rich GdC_2 was measured by the Knudsen effusion technique using an automatic recording balance. Knudsen pressures calculated on the basis that Gd(g) is the major gaseous species did not vary significantly as a function of orifice diameter or sample surface area. Corrections were made for a minor gaseous species, GdC_2(g). The entropy and heat content of GdC_2 were estimated. For the reaction Gd(l) = Gd(g) the third-law ΔH°_{298} of 95.2 ± 0.3 kcal/g-atom was in agreement with the second-law value of 97.3 ± 0.8 kcal/g-atom. Third- and second-law ΔH°_{298} were combined to give a value of 125 ± 9 kcal/mole for the reaction $GdC_2(s) = Gd(g) + 2C(s)$. From these values the enthalpy of formation of C-rich GdC_2 was calculated to be −30 ± 9 kcal/mole. Studies of rare earth dicarbide vaporization behavior are briefly reviewed and discussed, and their possible application to a self-purifying, high-temperature nuclear reactor is considered. (auth)

41597 STUDY OF SOME PHYSICAL PROPERTIES OF Ni_3Al–Ni_3Nb ALLOYS. Arbuzov, M. P.; Chuprina, V. G. Izv. Akad. Nauk SSSR, Metal., No. 3, 174-9(May–June 1967). (In Russian).

A series of Ni_3Al–Ni_3Nb alloys were melted in an Ar arc furnace, and homogenized in an evacuated quartz ampule at 1150°C for 70 hr. Ni_3Al compound was found to have the highest coefficient of thermal expansion. With increasing Ni_3Nb content, this coefficient gradually decreased and reached a minimum at 90 to 94% Ni_3Nb. Pure Ni_3Al compound had the lowest Young modulus and the lowest hardness. The Young modulus of all the alloys tested was found to decrease with increasing temperature. (ATD)

41598 ELECTROTRANSFER IN MOLYBDENUM-BASE ALLOYS. Kalinovich, D. F.; Kovenskii, I. I.; Smolin, M. D. Izv. Akad. Nauk SSSR, Metal., No. 3, 101-4(May–June 1967). (In Russian).

By means of radioactive isotopes ^{99}Mo and ^{185}W, the partial and total electrotransfer of matter in Mo-base alloys with 0.1, 15, 20, 25, 35, and 50 at. %/W was investigated. The impurity content in the alloys did not exceed 0.1 at. %. Wire specimens 0.5 mm in diameter and 70 mm long were used. The central part of the specimens (2 to 3 mm) was electrolytically marked with radioisotopes ^{99}Mo and ^{185}W. After applying a thin layer of these metals, the specimens were annealed in Ar (as a result, the isotopes were uniformly distributed in the cross section) and the position of radioactive zone was fixed. The specimens were then heated with direct current to a predetermined temperature and fixed a new position. Both the partial and total electrotransfer at 1400 to 2400°C were then calculated. In all the investigated alloys the Mo atoms moved toward the anode and the W atom, toward the cathode. For Mo–50%/W alloy, an inversion of sign occurred with total electrotransfer at 2200°C. (ATD)

41599 ANOMALOUS THERMAL CONDUCTIVITY IN GADOLINIUM BELOW 4°K. Karagyozyan, A. G.; Rao, K. V. (Oxford Univ.). Phys. Lett., 25A: 235-6(Aug. 14, 1967).

Anomalies at 1.3 and 3.5°K have been observed in the thermal conductivity of Gd. Considering the correlation between our data and the specific heat, a tentative explanation is suggested. (auth)

41600 THERMOPHYSICAL PROPERTIES OF TANTALUM, TUNGSTEN, RHENIUM, AND THEIR ALLOYS IN THE TEMPERATURE RANGE 1500 TO 3000°K. Hoch, M.; Jun, C. K. (Univ. of Cincinnati). Chimia (Aarau), 21: 290-5(July 20, 1967).

The thermal conductivities and total emittances of Ta, W, Re, and their alloys, Ta–10W, T-111, T-222, and W–25 Re were measured in the temperature range 1500 to 3000°K. From data in the literature, the high-temperature specific heats of these materials were computed. (auth)

41601 PHASE DIAGRAM OF THE NIOBIUM–TIN SYSTEM. Svechnikov, V. N.; Pan, V. M.; Beletskii, Yu. I. (Inst. of Metal Physics, Kiev). Dokl. Akad. Nauk SSSR, 173: 110-12(Mar.–Apr. 1967). (In Russian).

A series of Nb–Sr alloys containing 42.9 to 77 at. % Sn (49.0 to 81.6 wt %), from arc-melted and powdered Nb_3Sn compound, 99.9995%-pure Sn, and 99.6%-pure Nb, were arc-melted and annealed in an Ar atmosphere at 750 and 700°C and investigated by various methods of physico-chemical analysis. On the basis of the obtained data, a phase diagram of the investigated alloys was plotted and incorporated into a complete phase diagram of alloys of the Nb–Sn system. (ATD)

Structure and Phase Studies

Refer also to abstracts 40957, 41551–41553, and 41650.

41602 (EUR–3458.e) STATISTICAL TREATMENT OF INTERMETALLIC DIFFUSION DATA. Gloden, R. F.; Hubaux, A. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Jan. 24, 1967. 14p. Dep.

A regression method to extrapolate experimental values through the use of a non-linear relation of the form: $\varphi(x) = f_1(t_1) \cdot f_2(t_2) \cdot f_3(t_3) \ldots$ is given. x is the so-called dependent variable, the t are independent variables which are supposed to be measured without error, and φ and the functions f_1 each contain one parameter. The method has been conceived to study the diffusion behavior of metallic couples, through the use of the relation $X^n = k_0\, t \exp(-Q/RT)$ where X stands for the thickness of the diffusion zone, t for time and T for temperature; n, k_0 and Q are parameters. First, these parameters are estimated, by iterations, from the observations; then, tests are made to search possible changes in the values of these parameters; finally, the confidence limits of the extrapolated values of x are calculated. The computations are done with the help of a FORTRAN IV program. (auth)

41603 (UCRL–17549) LOW-ENERGY ELECTRON DIFFRACTION STUDY OF LOW-INDEX PLATINUM SINGLE CRYSTAL SURFACES. Lyon, Hylan Benton Jr. (California Univ., Berkeley. Lawrence Radiation Lab.). June 1967. Contract W-7405-eng-48. 111p. Dep. CFSTI.

Thesis.

The post-acceleration technique of Low Energy Electron Diffraction has been used to examine the three low index (100), (110), (111) crystal faces of Pt. The single crystal samples were sub-

jected to ion bombardment, ultra-high vacuum anneal and exposure to different gases. The changes in the diffraction features of Pt were correlated to these treatments in an attempt to explain the appearance of new surface structures. Several distinct sets of new diffraction patterns were observed as a function of these different treatments. These were characterized by the appearance of new periodicities in the diffraction pattern at well-defined ranges of electron beam energy. A high temperature anneal in ultra-high vacuum will generally lead to the formation of a disordered, highly unreactive structure which is the same for all three faces of Pt. The specular intensity was measured as a function of beam voltage. The Debye temperatures which characterize the mean displacement of the surface atoms perpendicular to the surface planes were measured for all three faces. The average value of the surface Debye temperature was measured. (auth)

41604 (UCRL-50209) DISPERSION STRENGTHENING OF TUNGSTEN BY COVAPOR DEPOSITION. Landingham, R. L.; Austin, J. H. (California Univ., Livermore. Lawrence Radiation Lab.). Feb. 24, 1967. 28p. Dep. CFSTI.

A new method is described for dispersion hardening W to improve its creep strength at high temperatures and thus make it more suitable for use in nuclear reactors for space applications. Called the covapor deposition technique, this method involves mixing vapors of WCl_x and $HfCl_x$ and reducing them with NH_3 and H_2 to produce a deposit of W interspersed with fine particles of HfN for strengthening. A by-product of the development of the covapor deposition technique is the discovery that finer grained vapor deposits of W can be achieved by partially nitriding the W to W_2N during deposition and later removing the W_2N by heat treatment above its 900°C decomposition temperature. (auth)

41605 STUDY OF ZIRCONIUM ALLOYS CONTAINING NIOBIUM AND VANADIUM. Raevskaya, M. V.; Sokolovskaya, E. M.; Sokolova, I. G.; Guzei, L. S.; Kim, K. S. Vestn. Mosk. Univ., Ser. II Khim., No. 2, 58-62(Mar.-Apr. 1967). (In Russian).

The Zr-Nb-V, Zr-Nb, and Zr-V systems were investigated by structural and x-ray analysis, by changes in hardness and microhardness, and by high-temperature thermal analysis. The phase diagram of the Zr-Nb-V system at 1000°C showed an initial breakdown of the beta solid solution at ~1150°C and a monotectoid conversion temperature of ~620°C. The Zr-V system showed a single chemical compound ZrV_2 (Laves phase), a eutectic reaction temperature of 1240°C, and a peritectic reaction temperature of 1360°C. Alloys of the Zr-Nb-V system were homogenized at two temperatures for 100 hrs; while alloys rich in Nb were treated at 1500°C and alloys on the Zr-V side at 1000°C. There was a wide two-phase region (up to 50% Nb) on the Zr-V side due to the presence of the ZrV_2 compound. A two-phase region $\beta_{(Zr)} + \beta_{(Nb)}$ was found on the Zr-Nb side. A study of Zr-Nb-V alloys quenched from temperatures of 700 and 500°C showed the presence of the ternary chemical compound $Zr(Nb,V)_2$, which could possibly exist up to temperatures of 1000°C. (TTT)

41606 THE CRYSTAL CHEMISTRY OF SELECTED AB_2 RARE EARTH COMPOUNDS WITH SELENIUM, TELLURIUM, AND ANTIMONY. Wang, R.; Steinfink, H. (Univ. of Texas, Austin). Inorg. Chem., 6: 1685-92(Sept. 1967).

The rare earth ditellurides, diselenides, and diantimonides were synthesized and their crystal structures were investigated. The ditellurides are isostructural and have the Fe_2As (C38) structure. The phases $HoTe_2$ and $ErTe_2$ did not exist and reasons for their absence are given. The structures of the diselenides displayed two types of supercells. The lighter rare earths have a tetragonal cell and the heavier ones have an orthorhombic cell, but the subcell had an arrangement identical with the telluride structure. The diantimonides were formed by a limited number of rare earths and they crystallized with a new structure which, however, was closely related to the $RETe_2$ type and to the $ZrSi_2$ structure. The phase $YbSb_2$ crystallized in the latter type. The interrelationships among these structures and the nature of the bonding existing in these compounds is discussed. (auth)

41607 EFFECTS OF A UNIAXIAL COMPRESSION RESTRAINT OF THE KINETICS OF THE $\beta \rightarrow \alpha$ TRANSFORMATION OF U-Cr ALLOYS AND THE FINENESS OF THE α GRAIN. Violle, Michael (Faculte des Sciences, Nancy. ENSMIM, Nancy. CEA, Gif-sur-Yvette, France). Compt. Rend., Ser. C, 264: 1920-2(June 12, 1967). (In French).

With a compression frame a uniaxial constraint of 25 kg/mm² was exerted before and during the $\beta \rightarrow \alpha$ transformation of U-Cr alloys containing from 0.37 to 4.00 at. % Cr. The incubation period was considerably reduced. The α grain was improved when the operation was at temperatures at which the germination is the slowest phenomenon and therefore controls the transformation. (tr-auth)

41608 THE CRYSTAL STRUCTURE OF $Pu_2Zn_{\sim 9}$. Larson, Allen C.; Cromer, Don T. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. Acta Crystallogr., 23: 70-7(1967). (LA-DC-7592).

$Pu_2Zn_{\sim 9}$ has a hexagonal subcell with a = 14.43 and c = 14.14 Å, probable space group $P6_3/mmc$. The true unit cell appears to be hexagonal with a doubled a axis but this apparent hexagonal symmetry may result from twinning. A reasonable solution was obtained for the subcell and led to the formula $Pu_{18}Zn_{58}$ or $PuZn_{4.44}$. The subcell is similar to and probably isostructural with recently reported phases $Ce_2Cd_{\sim 9}$, $Ce_2Zn_{\sim 9}$, and $Y_2Zn_{\sim 9}$. (auth) (DENMARK)

41609 PHASE DIAGRAMS AND PROPERTIES OF YTTRIUM-TERBIUM, YTTRIUM-DYSPROSIUM, AND YTTRIUM-HOLMIUM ALLOYS. Markova, I. A.; Terekhova, V. F.; Savitskii, E. M. (Inst. of Metallurgy, Moscow). Izv. Akad. Nauk SSSR, Neorg. Mater., 3: 392-4(Feb. 1967). (In Russian).

A series of yttrium-terbium, yttrium-dysprosium, and yttrium-holmium alloys were melted from 99.6 to 99.7%-pure yttrium, dysprosium, and holmium and 98.5 to 99.0%-pure terbium. The alloys were melted in a nonconsumable tungsten electrode arc furnace in a pure helium atmosphere, annealed at 850°C for 70 hr, and investigated by various methods of physicochemical analysis. The electric resistivity of all pure metals and alloys was measured on wire or foil cold drawn or rolled with process annealing for 20 to 30 min in a vacuum of $5 \cdot 10^{-5}$ mm Hg. On the basis of the data obtained phase diagrams of the Y-Tb, Y-Dy, and Y-Ho systems were plotted. All investigated metals and alloys had a close-packed hexagonal lattice of the magnesium type. The phase diagrams confirmed the presence in these alloys of a continuous series of solid solutions between the isomorphic modifications of the investigated metals. The alloys are ductile and have relatively high oxidation resistance in air at room temperature and high electric resistivity, particularly alloys containing 40 to 50 at. % Y. (ATD)

41610 THE CRYSTAL STRUCTURE OF Er_2Co_7 AND OTHER RARE EARTH COBALT COMPOUNDS R_2Co_7 (R = Gd, Tb, Dy, Ho, Tm, Lu, Y). Ostertag, W. (Air Force Materials Lab., Dayton, Ohio). J. Less-Common Metals, 13: 385-90(1967).

Compounds of the R_2Co_7 series, where R is Gd, Tb, Dy, Ho, Er, Tm, Lu and Y, were prepared by the levitation melting technique. The compounds are isostructural and have rhombohedral symmetry; the most probable space group is $R\bar{3}m$. The lattice constants of the triply primitive hexagonal unit cells are given. There are six formula units per hexagonal unit cell. The structure of the R_2Co_7 compounds consists of double layers of RCo_5 alternating with double layers of RCo_2. The atomic positions of Er_2Co_7 were refined employing least-squares structure refinement. General principles as discussed by Frank and Kasper are used in the classification of the R_2Co_7 structure. (auth)

41611 DENSIFICATION AND GRAIN GROWTH DURING LIQUID-PHASE SINTERING OF TUNGSTEN-NICKEL-COPPER ALLOYS. Kothari, N. C. (Univ. of Queensland, Brisbane). J. Less-Common Metals, 13: 457-68(1967).

The kinetics of liquid-phase sintering in W-Ni-Cu alloys were examined in the temperature range 1200°-1500°C. The rate constant of the sintering process was evaluated from the volume change as a function of sintering time. The activation energy for the sintering process was about 70 kcal/mole in all three compositions and was independent of the binder phase composition. The average growth of W particles was examined as a function of sintering time in W-3 Ni-8 Cu and W-7 Ni-4 Cu alloys and it was found that mean grain size increased at a rate which was proportional to sintering time, $t^{\frac{1}{3}}$. The activation energy of grain growth was 67 kcal/mole in both systems and is in good agreement with those of 68 kcal/mole determined by the Greenwood's equation and 70 kcal/mole derived for liquid-phase sintering experiments carried out under the same conditions. (auth)

41612 COMMENTS ON "THE ALUMINIUM-RICH PARTS OF THE Al-Sm AND Al-Dy SYSTEMS." Buschow, K. H. J.; van Vucht, J. H. N. (Philips Research Labs., Eindhoven, Netherlands). J. Less-Common Metals, 13: 369-70(Sept. 1967).

Crystal structures and phase transformations of Al alloyed with rare-earth metals are discussed. It was found that the trialuminides may deviate from stoichiometry at high temperatures and that various kinds of stable modifications may occur dependent on small changes in conditions of growth. (P.G.C.)

41613 HARDENING AND RECRYSTALLIZATION IN Al-0,5 PERCENT Zr. Ryum, Nils (Sentralinstitutt for Industriell Forkning, Oslo); Bjoergum, Per Kristian. Tidsskr. Kjemi, Bergv. Met., 27: 77-81(Apr. 1967). (In Norwegian).

Hardening mechanisms such as deformation and precipitation hardening, are discussed in general terms, and some semi-quan-

titative expressions for the flow stress are given. The results are used to interpret hardening behavior observed in an Al-0.5% Zr alloy. In this alloy a very stable intermetallic phase is precipitated on aging at 500°C after rapid solidification. The influence of this stable phase on the deformation and recrystallization structures has been studied. (auth)

41614 EFFECT OF DEFORMATION ON THE TRANSFORMATIONS OCCURING IN Ni–Mo ALLOY DURING ANNEALING. Dubrovina, A. N.; Umanskii, Ya. S. Izv. Akad. Nauk SSSR, Metal., No. 3, 180-5(May-June 1967). (In Russian).

Changes in the hardness, electrical resistance, and phase composition of Ni–20.76 at. % Mo alloy quenched from 1200°C (one phase γ-region), deformed with drawing by 40% (from 8 mm diameter to 5.6 mm), and annealed at 500 to 800°C for 10 min to 100 hr were investigated. According to the Ni–Mo phase diagram in the equilibrium condition below 860°C the alloy has an ordered structure of Ni_4Mo with bc tetragonal lattice. Phase transformation from the γ-region to Ni_4Mo consists of the formation and development of domains with a bc tetragonal lattice. Deformation essentially changes the nature of transformation during annealing. X-ray diffraction patterns showed that 3 phases existed in the alloy during the transformation process: γ-solid solution and two ordered phases (Ni_3Mo and Ni_4Mo). Traces of the Ni_3Mo phase appeared after 10 hr annealing at 600°C and Ni_4Mo after 30 min annealing at 700°C. After 100 hr annealing at 700°C, the alloy consisted of 62% Ni_4Mo, 16% Ni_3Mo, and remainder γ-phase, and after 100 hr annealing at 800°C, 70% Ni_4Mo, 26% Ni_3Mo, and the remainder γ-phase. The dependence of the hardness and electrical resistance of the alloy on temperature and time are graphed. (CFSTI)

41615 THE CRYSTAL STRUCTURE OF Ce_5Hg_{21}. Berndt, A. F. (Univ. of Missouri, St. Louis). J. Less-Common Metals, 13: 366-8(Sept. 1967).

The pyrophoric compound Ce_5Hg_{21} was prepared by heating stoichiometric amounts of the elements in vacuum at 300°C for about 2 weeks. Powder patterns indicate that the compound is isomorphous with Pu_5Hg_{21}. X-ray density is 12.38 g/cm^3. (P.G.C.)

41616 TAPIOLITE FILM FORMED ON TANTALUM IN HIGH-TEMPERATURE WATER. Nakayama, T.; Osaka, T. (Waseda Univ., Tokyo). J. Less-Common Metals, 13: 360-3(Sept. 1967).

Oxide films formed on Ta surfaces immersed in deionized water at 300°C were analyzed by electron diffraction and electron probe microanalysis methods. It was determined that the film was tapiolite of the probable composition $(Fe,Ta)O_2$. (P.G.C.)

41617 THE SOLID-SOLUBILITY OF OXYGEN IN Nb AND Nb-RICH Nb–Hf, Nb–Mo AND Nb–W ALLOYS. PART III. THE TERNARY SYSTEMS Nb–Mo–O AND Nb–W–O. Taylor, A.; Doyle, N. J. (Westinghouse Research Labs., Pittsburgh). J. Less-Common Metals, 13: 338-51(Sept. 1967).

Both Mo and W additions reduce the interstitial solid-solubility of O_2 in Nb. Thus, at 1500°C, the solid-solubility of O_2 in Nb, which is 4.75 at. % at zero Mo, drops to about 1.75 at. % at 10.5 at. % Mo. Similarly, the addition of 10.5 at. % W causes the solid-solubility of O_2 at 1500°C to fall to 2.3 at.%. The lattice parameter of Nb is increased by the addition of O_2 but decreased by the additions of either Mo or W. However, unlike the Nb–Hf–O system, the mutual effects of O_2, Mo and W on the lattice parameter of Nb are additive so that the isoparametric contours run as straight lines across the α-Nb phase field in the two ternary systems Nb–Mo–O and Nb–W–O. (auth)

41618 THE SOLID-SOLUBILITY OF OXYGEN IN Nb AND Nb-RICH, Nb–Hf, Nb–Mo AND Nb–W ALLOYS. PART II. THE TERNARY SYSTEM Nb–Hf–O. Taylor, A.; Doyle, N. J. (Westinghouse Research Labs., Pittsburgh). J. Less-Common Metals, 13: 331-7(Sept. 1967).

The lattice parameter of b.c.c. Nb is increased when O_2 is taken into interstitial solid solution. It is also appreciably increased when Hf is taken into solid solution substitutionally. Surprisingly enough, the addition of O_2 to a Hf-containing Nb alloy does not necessarily produce an additional increase in lattice parameter as expected, but first produces a sharp decrease followed by an increase. It is found that a minimum occurs in the isoparametric curves at an O_2-to-Hf ratio of 2:1 and with a lattice parameter almost identical with that of pure Nb, namely 3.2986 Å, this minimum passing through the Nb corner of the diagram and continuing into the tie-line linking the α-Nb solid-solubility limit with the phase HfO_2. A possible reason for this behavior is the formation of Preston–Guinier zones of effective composition HfO_2, or alternatively, a form of clustering occurs in which randomly dispersed "molecules" of HfO_2 form within the Nb lattice. (auth)

41619 THE SOLID-SOLUBILITY OF OXYGEN IN Nb AND Nb-RICH Nb–Hf, Nb–Mo AND Nb–W ALLOYS. PART I. THE Nb–O SYSTEM. Taylor, A.; Doyle, N. J. (Westinghouse Research Labs., Pittsburgh). J. Less-Common Metals, 13: 313-30(Sept. 1967).

The interstitial solid-solubility of O_2 in Nb has been studied by means of x-ray diffraction, micrographic and thermal techniques using both a dynamic leak method and a Sieverts apparatus. The lattice parameter of degassed, zone-refined Nb was found to be 3.2986 Å, which is much lower than hitherto published values. At pressures above 10^{-11} torr O_2, Nb is in thermodynamic equilibrium with oxide vapor and can take up to 6 at. % O_2 into solid solution at 1775°C. Above this temperature oxidation is "catastrophic" and the volatile oxides Nb_2O, NbO and Nb_2O_5 form on the surface. The "degassing" of Nb at 2200°C and above at a pressure of 10^{-6} torr O_2 is, in effect, brought about by the volatilization of the oxide and not by the de-adsorption of gaseous O_2. (auth)

41620 THE CONSTITUTION OF CERIUM–PALLADIUM ALLOYS CONTAINING 50 TO 100 PERCENT PALLADIUM. Thomson, J. R. (Imperial Coll. of Science and Tech., London). J. Less-Common Metals, 13: 307-12(Sept. 1967).

The Ce–Pd system has been studied over the composition range 48–100% Pd between 800°C and the melting points, mainly by metallographic and X-ray methods. The solubility of Ce in Pd at 800°C and at 1050°C is 13 ± 1%. Four intermetallic compounds were observed; CePd and $CePd_3$ crystallize directly from the melt at 1137° ± 12° and 1437° ± 12°C, respectively, while compounds occurring at 57 ± 1% (X) and 62.5 ± 1% Pd (Y) form peritectically at 1137° ± 12° and 1037° ± 12°C, respectively. $CePd_3$ forms eutectics with Y and with the Pd-rich solid solution at 64 ± 1% Pd and 987° ± 12°C, and 84 ± 1% Pd and 1075° ± 12°C, respectively. The results are compared with those obtained earlier on the Th–Pd system. (auth)

41621 TWINNING AND THE LOW TEMPERATURE MECHANICAL PROPERTIES OF POLYCRYSTALLINE NIOBIUM AND MOLYBDENUM. Shaw, B. J. (Westinghouse Research Labs., Pittsburgh). J. Less-Common Metals, 13: 294-306(Sept. 1967).

The mechanical properties of high-purity Nb and Mo specimens have been investigated over a range of grain sizes from 20°C to –269°C. Interpretation of the load–elongation curves, in compression and tension, along with detailed metallographic investigation has led to the following conclusions: twinning can occur more readily in coarse-grain than fine-grain material, twins can occur over the entire range of temperature 20°C to –269°C in Mo but only in the range –150° to –269°C in Nb at $\dot{\epsilon} = 4.210^{-4}$ sec^{-1}, and enhanced stresses ahead of a crack can cause twinning but there is no definite evidence to show that twins cause cracking. The results have been discussed by interpreting the effect of grain size in terms of dislocation density, the effect of temperature and strain rate in terms of dislocation mobility and the advent of twinning in terms of a model independent hypothesis based on simple considerations of the dissipation of energy by various deformation mechanisms. (auth)

41622 CONSTITUTION OF URANIUM-BASE URANIUM–ALUMINUM–MANGANESE ALLOYS. Petzow, G.; Sampaio, A. O. (Max-Planck-Institut fuer Metallforschung, Stuttgart. Laboratorio de Fisica e Engenharia Nucleares, Sacavem, Portugal). J. Less-Common Metals, 13: 281-93(Sept. 1967). (In German).

The constitution of U-rich U-Al-Mn alloys has been established by thermal, x-ray, and microscopic studies up to the pseudo-binary section of UAl_2–UMn_2. Surfaces of primary solidification, the non-variant equilibria as well as numerous isothermal and temperature-concentration diagrams are presented and discussed. In total, four non-variant melt equilibria are exhibited at 850, 730, 710, and 705°C. Furthermore, three four-phase solid-state transformations caused by the γ and β modifications of U occur at 720, 640, and 610°C. The solubility of the homogeneous phases is low, in the case of U_6Mn practically zero. The system U–UAl_2–UMn_2 is dominated by extended heterogeneous areas involving the ternary phase $U(Al,Mn)_2$. (auth)

41623 STRUCTURE OF POWDERED METAL W–Ni–Fe ALLOYS. Minakova, R. V.; Pilyankevich, A. N.; Teodorovich, O. K.; Frantsevich, I. N.; Shiyanovskaya, I. E. pp 91-105 of Proceedings of the 2nd International Powder Metallurgy Conference, Stary Smokovec, Czechoslovakai, September 27–30, 1966. Present-Day Problems of Powder Metallurgy. Vol. II. Prague, Academia, 1966. (In Russian).

See CONF-660915–(Vol.2).

X-ray spectral and micro- and x-ray structural analyses were made in order to determine the influence of composition, treatment, and plastic deformation on the structure of W–Ni–Fe alloy cermets. (R.V.J.)

41624 CATION DIFFUSION IN FLUORITE LATTICES. Hawkins, R. J. London, Imperial Coll. of Science and Tech., 1967. 239p.

Thesis.

Volume diffusion coefficients were determined for ^{233}U self-diffusion in stoichiometric and non-stoichiometric UO_2, and for ^{230}Th self-diffusion in ThO_2. Concentration profiles were determined by α-ray spectrometry. It was possible to measure diffusion coefficients of between about 10^{-15} and 10^{-12} cm^2/sec. It was shown that grain boundary diffusion occurs in single crystal and polycrystalline UO_2. Expressions are derived for ^{233}U self-diffusion in UO_2, over the composition range UO_2 to $UO_{2.15}$. The ratio of the grain boundary coefficient to the volume diffusion coefficient was about 10^5 for all compositions. U diffusion increased very rapidly for small departures from the stoichiometric composition. The activation energy increased with increasing values of x in UO_{2+x} up to $x = 0.1$, after which it decreased. O_2 partial pressure had little effect on cation diffusion in ThO_2. An attempt to correlate physical properties with self-diffusion coefficients in UO_2 suggested that sintering and fission gas release are closely related to O_2 diffusion rather than to U diffusion. (UK)

41625 APPARATUS DEVELOPMENT FOR GROWTH OF SINGLE CRYSTALS OF HIGH-MELTING METALS. Barthel, J.; Scharfenberg, R. (Institut fuer Metallphysik und Reinstmetalle, Dresden). 14p. (In German). (CONF-650939-4). DTIE.

From 2nd International Symposium on Hyperpure Products in Science and Technology, Dresden.

Single crystals of high-melting metals are preferentially grown by electron-beam floating-zone melting. The influence of the electron focusing device used in this method and of the freezing direction on the stability of the molten zone and on the geometrical shapes of the solid-liquid interface and the grown crystals is described. As a result of the experiments, optimal focusing devices were developed, which also guaranteed a stable growth of the crystals. Further experiments with radioactive isotopes showed only an insignificant increase of the W concentration in the crystals, when W filaments were used for melting of other materials. By a suitable pretreatment and a specially developed holder it was possible to give W cathodes a stable position in the focusing device. (auth)

41626 ATOMIC AND ELECTRONIC STRUCTURE OF METALS. Papers Presented at a Seminar of the American Society for Metals, Chicago, October 29–30, 1966. Metals Park, Ohio, American Society for Metals, 1967. 266p. (CONF-661031).

Subjects discussed in the presented papers include: simple metals and pseudopotential theory; experimental determination of electronic structure of metals; valence and alloy structure for monovalent and polyvalent solvents; the electronic structures of transition and noble metals; observation of crystal fields by means of the Mössbauer effect; band structure and bonding in titanium carbide; phonons; electronic excitations in metals; atom movements in metals; magnetism in metals; lattice dynamics of point defects; and dislocations and electrons in metals. (D.C.C.)

Radiation Effects

Refer also to abstract 41575.

41627 (NRL-6575) THROUGH-THICKNESS NOTCH DUCTILITY AND TENSION PROPERTIES AS A FUNCTION OF NEUTRON EXPOSURE TO A SIMULATED PRESSURE VESSEL WALL OF A302-B STEEL. Serpan, Charles Z. Jr.; Hawthorne, J. Russell (Naval Research Lab., Washington, D. C.). Mar. 31, 1967. Contract AT(49-5)-2110. 13p. Dep. CFSTI.

Notch ductility and tension-property measurements have been made using specimens irradiated within a large steel test assembly simulating the pressure-vessel wall of a light-water-moderated power reactor. The A302-B steel specimens, spaced at intervals through the 6 in. thickness of the assembly, showed the greatest embrittlement and tensile property changes from irradiation locations nearest the fuel core, and correspondingly smaller changes farther from the core. Measured neutron fluxes of energies greater than 1 MeV, based upon an assumed fission spectrum, compared well with calculated spectrum neutron fluxes of energies greater than 1 MeV for all test assembly locations, thus providing the basis for future estimates of property changes through the thickness of heavy-walled reactors. (auth)

41628 EFFECTS OF THE NATURE OF THE ADDITION ELEMENTS ON THE ELIMINATION OF DEFECTS IN ALUMINIUM IRRADIATED WITH NEUTRONS AT 78°K. Frois, Colette; Dimitrov, Omourtague (CNRS, Vitry-sur-Seine, France). Compt. Rend., Ser. C, 264: 1923-6(June 12, 1967). (In French).

The presence of a 100 ppM of an addition element increased the resistivity excess produced in Al by irradiation at 78°K. The supplementary resistivity due probably to defects trapped by the additive atoms is eliminated principally either between 90 and 165°K (case of Mg and Ag) or between 165 and 235°K (case of Cu). This behavior appears to be connected with the atomic radius of the addition element. (tr-auth)

41629 SELF-IRRADIATION EFFECTS IN A CERIUM ALLOY CONTAINING 15 AT. PERCENT PLUTONIUM. Elliott, R. O.; Miner, W. N.; Clinard, F. W. Jr. (Los Alamos Scientific Lab., N. Mex.). J. Less-Common Metals, 13: 274-80(Sept. 1967). (LA-DC-8415).

Four samples of an α-phase Ce alloy (85 at. % Ce–15 at. % Pu) were stored at 20°K for 1076 hr. The Pu used in making the samples was variably enriched with the ^{238}Pu isotope to provide four different levels of irradiation. Accumulation of lattice damage due to the alpha activity of Pu was followed by periodically measuring the electrical resistivities of the samples during storage at low temperature. Annealing of damage was then followed from 20° to 350°K, by the isochronal method. Results are discussed in terms of the nature of lattice damage. (auth)

41630 EFFECT OF NEUTRON IRRADIATION ON THE PLASTIC FLOW OF ZINC CRYSTAL. Kim, Key-soo (Atomic Energy Research Inst., Seoul); Maeng, Sun-chae. New Phys. (Korea), 6: 66-8(Dec. 1966). (In Korean).

Plastic flow curves of irradiated Zn single crystals were compared with unirradiated crystals of the same crystal orientation. After 10 months irradiation in specimen rack of the TRIGA II Reactor (fast neutron: 1.7×10^{18} nvt, thermal neutron: 3.2×10^{18} nvt) critical shear stress was increased by 4 to 27%. (auth)

41631 INVESTIGATIONS OF (n,γ) RECOIL DAMAGE IN VANADIUM BY NUCLEAR-RESONANCE FLUORESCENCE METHODS. Kalus, J.; Neuhauser, J. (Technische Hochschule, Munich). Z. Naturforsch., 22a: 792-6(May 1967). (In German).

Nuclear resonance fluorescence measurements were made on the 1.43-MeV level of ^{52}Cr at 10 and 300°K. Neutron-irradiated polycrystalline V metal and a V single crystal served as γ sources for the resonance scattering experiment. With the help of a simple slowing-down model data were obtained on the concentration of lattice defects in the immediate vicinity of ^{52}Cr atoms at 10°K. By neglect of double defect sites values were obtained for concentration of normal lattice spaces, concentration of interstitial lattice spaces, concentration of vacancies in the nearest neighboring sites, and concentration of vacancies in the next neighboring sites. The concentrations are not independent of each other since their total is 1. (tr-auth)

41632 RADIATION GROWTH AND SWELLING ANALYSIS FOR STRAINS AND STRESSES IN SHORT CYLINDRICAL FUEL ELEMENTS. Ma, Benjamin M. (Iowa State Univ., Ames). Nucl. Eng. Design, 5: 375-85(July 1967).

Based on the present, accepted experimental results of radiation growth and swelling in nuclear fuels, a theoretical analysis for strain and stress distributions in short solid-cylindrical fuel elements is presented. The exact solutions and the modified Bessel functions for neutron flux distribution and temperature distribution in the fuel elements are respectively obtained from the simple diffusion equations and Poisson's heat conduction equation. The strain and stress equations for the fuel elements are derived. From the calculated results of a numerical example, the components of strain and stress produced in the fuel elements are shown by the curves. For purposes of comparison, the strain and stress distributions developed in the long, solid-cylindrical fuel elements are also given. From the results of comparison it appears that short fuel rods or slugs offer definite advantages over long fuel elements when the stability of fuel element and burn-up level are concerned. (auth)

41633 ANNEALING SPECTRUM OF ELECTRON-IRRADIATED NIOBIUM AND TANTALUM FROM 13K TO 301°K. El-Salam, Ehab M. Abd; DeFord, J. W. (Univ. of Utah, Salt Lake City). Phys. Rev., 161: 600-10(Sept. 15, 1967).

The annealing of Nb and Ta irradiated at 13°K with 2-MeV electrons has been investigated from 13 to 301°K. Peaks are found at 24.0, 99.1, and 135.7°K in Nb and at 27.4, 34.2, 40.9, 124.5, and 157.0°K in Ta. Annealing curves, damage-production curves, and activation energies are given. (auth)

Ceramics and Cermets

Refer also to abstracts 41530–41532.

41634 PROCEEDINGS OF THE 2nd INTERNATIONAL POWDER METALLURGY CONFERENCE, STARY SMOKOVEC, CZECHOSLOVAKIA, SEPTEMBER 27–30, 1966. PRESENT-DAY PROBLEMS OF POWDER METALLURGY. VOLUME IV. SUPPLEMENTS. Prague, Academia, 1966. 161p. (In Several Languages). (CONF-660915-(Vol.4)).

Twelve papers presented at the conference are included; two of them have been abstracted for inclusion in NSA. The following topics are discussed in the other ten papers: direct reduction of iron oxides by methane; preparation of cemented and complex carbides; relation between the production method of alloyed sintered materials and sintering time; oxide dispersion strengthened alloys; preparation of dispersion strengthened sintered materials from powders atomized by manifold streams of water; relation between wear and basic physical characteristics of metal and alloys; the influence of dispersity on thermoelectric properties of a Bi–Te–Sb alloy; fiber reinforced aluminum; and, isostatic pressing. (J.G.B.)

For abstracts of individual papers see: 41643 and 41644.

Corrosion and Erosion

Refer also to abstract 41111.

41635 WC–NbC–Co ALLOY RESISTANCE TO OXIDATION IN THE OPEN AIR. Meerson, G. A.; Panov, V. S. (Moscow Inst. of Steel and Alloys). Porosh. Met. Akad. Nauk Ukr. SSR, No. 8, 60-4(Aug. 1967). (In Russian).

Oxidation of WC–NbC–Co alloys with various contents of NbC with a stable cobalt content (25 vol %) over the range of temperatures from 500 to 800°C was studied. Introduction of NbC into the WC–Co alloys decreased their resistance to oxidation. Oxidation of WC–NbC–Co occurred according to the law, approaching the linear one, that is conditioned by inclination of oxide films to cracking. Phase composition was determined for oxide films that formed on WC–NbC–Co alloys. Increase of holding periods and rise of oxidation temperature from 500 to 800°C did not affect composition greatly. (auth)

Preparation and Fabrication

Refer also to abstracts 40959, 41565, 42732, and 42843.

41636 (AERE-R-5441) RESEARCH ON PLUTONIUM NITRIDE. Bridger, N. J.; Dell, R. M. (Atomic Energy Research Establishment, Harwell (England)). June 1967. 22p. Dep. CFSTI, UK 4s. 6d.

PuN was prepared as a pure, stoichiometric compound by reacting Pu metal with N_2 in the presence of H_2. PuN crystallises in the rock-salt system, with a lattice parameter ranging from 4.9033Å for O_2-free PuN to about 4.908Å for O_2-saturated PuN. Excess O_2 is present as PuO_2 at low temperatures, but above ~1000°C this reacts with PuN to yield hexagonal Pu_2O_3; $PuN + 3PuO_2 \rightarrow 2Pu_2O_3 + \frac{1}{2}N_2$. When heated in O_2 PuN oxidises above 200°C at a rate similar to that of UN. Ignition occurs around 280°C, depending on the particle size. The presence of water vapour facilitates oxidation and ignition takes place in wet oxygen at a temperature as low as 90°C. Mixed nitrides of composition $(U_{0.7}Pu_{0.3})N$ were prepared by hot pressing above 1500°C. These are considerably more resistant than pure PuN to attack by atmospheric moisture. (auth)

41637 (KAPL-P-3368) BALLMILLING WITH GAS COLLECTION IN THE RADIOACTIVE MATERIALS LABORATORY. Krastins, G.; Jagielski, E. J. (Knolls Atomic Power Lab., Schenectady, N. Y.). June 1967. Contract W-31-109-eng-52. 9p. (CONF-671102-8). Dep. CFSTI.

For Presentation at 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill.

Vacuum ballmilling with gas collection was used in post-irradiation studies to determine the amount of fission gases of He that can be released by mechanical means from fuel and poison materials. Objectives were to determine the fraction of fission gases located in discrete gas pores as opposed to the atomic lattice in UO_2, to obtain material for determination of solid fission-product contributions to UO_2 swelling during irradiation, to obtain information regarding the location (gas pores vs atomic lattice) of irradiation-generated He in fuel and poison materials, and to estimate the maximum amount of He that can be released from fuel and poison materials on mechanical disintegration. Light microscopy of unirradiated UO_2 showed particle size in the order of 1 micron or less after ballmilling; irradiated UO_2 is expected to disintegrate to finer particle size because of the presence of high gas pressure pores. Irradiated boron–stainless steel was ground to a fine powder and metallographic determination of final particle size was tried unsuccessfully. Observations indicated that the final particle size may depend on the original sample size, i.e., larger samples of the same material released smaller fractions of the gas contained in the specimen. This may be due to the packing effect of partially ground powder. Sample sizes that were successfully ballmilled were in the order of 0.5 g. (P.C.S.)

41638 NEW TENDENCIES IN THE PREPARATION OF NUCLEAR FUEL. II. Baran, Vaclav (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Jad. Energ., 13: 285-91(Aug. 1967). (In Czech).

Attention is paid to the formation of solid phases of tetravalent U and its separation from mother liquor. Colloidal properties of U(IV) hydrosols and possibilities of their utilization in the preparation of ceramic materials are described, as well as various ways of their preparation. Individual variants of the methods of wet preparation of nuclear fuel are compared; the relative preferences should be influenced to a great extent by the conditions under which they would be realized. (auth)

41639 INVESTIGATION OF FREELY FILLED POWDERS OF TITANIUM AND ZIRCONIUM CARBIDES. Kushtalova, I. P. (Inst. of Problems of Material Management, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR, No. 8, 7-9(Aug. 1967). (In Russian).

Sintering of freely filled powders of titanium and zirconium carbides over the range of temperatures from 1400 to 2100°C was described. A linear rate of growth of powder particles for various temperatures was determined as well as the activation energy of sintering processes, which is 58 ± 1.5 kcal/mol for TiC and 63 ± 1 kcal/mol for ZrC. (auth)

41640 ON THE OBTAINING OF GADOLINIUM, TERBIUM, DYSPROSIUM, ERBIUM, THULIUM, AND LUTETIUM DICARBIDES. Makarenko, G. N.; Kvas, O. F. (Inst. of Problems of Material Management, Kiev. Porosh. Met., Akad. Nauk Ukr. SSR, No. 8, 34-8(Aug. 1967). (In Russian).

To obtain dicarbides the vacuum-thermal method was used to reduce the oxides of rare earth metals with carbon according to the reaction: $Me_2O_3 + 7C = 2MeC_2 + 3CO$, where Me = Gd, Tb, Dy, Er, Tm, and Lu. The effect of temperature, time of heating, and charge composition on the process of reduction–carbidization was investigated. The experiment results were estimated according to the data of chemical and x-ray analyses. It is determined that 1800°C is an optimum temperature for obtaining Gd, Tb, Dy, Er, Tm, and Lu dicarbides. It is supposed that the dicarbide formation at one and the same temperature is connected with the similarity of electronic structure of rare earth metals. (auth)

41641 ANOMALOUS SINTERING BEHAVIOR OF Y_2O_3. Schieltz, J. D.; Wilder, D. R. J. Amer. Ceram. Soc., 50: 439-40(Aug. 21, 1967).

Assuming a temperature-dependent end-point density, the sintering behavior of Y_2O_3 was studied. Low values were obtained for the time dependence of the shrinkage, which could not be explained by the sintering models based on volume and grain-boundary diffusion. Investigations showed that the powder contained particles composed of crystallite agglomerates. In this case, grain boundaries between the particles may not be the only sinks for vacancies. A least-squares fit of the data gave an activation energy between 1210 and 1643°C as 23.1 kcal/g mole. The linear dependence of the limiting isothermal shrinkage indicates that an invariant combination of mechanisms or a single mechanism of material transport predominates over this temperature range. (P.C.S.)

41642 PYROLYTIC GRAPHITE. Knippenberg, W. F.; Lersmacher, B.; Lydtin, H.; Moore, A. W. Philips Tech. Rev., 28: 231-42(1967).

C layers deposited on substrates at temperatures above 2000°C from a C-containing gas have a clearly oriented graphite structure. C of this kind is known as pyrolytic graphite. The anisotropy of the properties of these deposits and their greater chemical inertia as compared with normal graphite widen the useful scope of C for scientific research and industrial applications. Pyrolytic graphite is compared with the ideal graphite crystal. When pyrolytic graphite is recrystallized under pressure a piece of graphite can be obtained that closely resembles the ideal crystal. After a thermodynamic treatment of the C transport properties of various gas systems, the conditions under which pyrolytic graphite is deposited are examined. A practical method of preparation is described and a number of applications are mentioned. (auth)

41643 SINTERING CONDITIONS OF LANTHANUM HEXABORIDE. Meerson, G. A.; Mamedov, F. G. pp 90-104 of Proceedings of the 2nd International Powder Metallurgy Conference, Stary Smokovec, Czechoslovakia, September 27–30, 1966. Present-Day Problems of Powder Metallurgy. Vol. IV. Prague, Academia, 1966. (In Russian).

See CONF-660915-(Vol.4).

Preparation of compact specimens from high-purity LaB_6 by cold pressing fine-grain powders followed by sintering in a vacuum at 2000 to 2200°C, Ar at 2200 to 2450°C, or H_2 at 1800 to 2000°C was investigated. (R.V.J.)

41644 ACTIVATION SINTERING OF ZIRCONIUM BORIDE. Meerson, G. A.; Gorbunov, A. E. pp 133-43 of Proceedings of the 2nd International Powder Metallurgy Conference, Stary Smokovec, Czechoslovakia, September 27–30, 1966. Present-Day Problems of Powder Metallurgy. Vol. IV. Prague, Academia, 1966. (In Russian).

See CONF-660915–(Vol.4).

Chemical-activation sintering produced practically poreless ZrB_2 specimens. Reactions of impurities such as ZrO_2 and B initiated reduction of ZrO_2 by C, producing highly mobile Zr atoms, which react with B atoms forming fine, highly energetic ZrB_2 grains, which in turn accelerate diffusion processes on the particle surface and in the adjacent areas, intensifying the shrinkage. The aging time at maximum sintering time as a function of shrinkage, effects of 500 kg/cm^2 pressure, and the microstructure of sintered specimen of ZrB_2 were determined. (R.V.J.)

41645 PROCEEDINGS OF THE 2nd INTERNATIONAL POWDER METALLURGY CONFERENCE, STARY SMOKOVEC, CZECHOSLOVAKIA, SEPTEMBER 27–30, 1966. PRESENT-DAY PROBLEMS OF POWDER METALLURGY. VOLUME I. THEORY OF POWDER METALLURGY PROCESSES. PREPARING OF POWDERS, MOLDING, SINTERING. Prague, Academia, 1966. 251p. (In Several Languages). (CONF-660915–(Vol.1)).

Twenty papers presented at the conference are included. Separate abstracts were prepared for 5 of the papers. (M.C.G.)

For abstracts of individual papers see: 41646–41649 and 41668.

41646 EFFECT OF GASEOUS IMPURITY CONTENTS DURING SINTERING OF URANIUM DIOXIDE. Francois, B.; Kurka, G.; Delmas, R. pp 177-93 of Proceedings of the 2nd International Powder Metallurgy Conference, Stary Smokovec, Czechoslovakia, September 27–30, 1966. Present-Day Problems of Powder Metallurgy. Vol. I. Prague, Academia, 1966.

See CONF-660915(Vol.I).

The influence of small amounts of gases created and able to evolve during the sintering stages of UO_2 was analyzed. Relatively high carbon contents in the green pellets may result in carbon monoxide formation at the sintering temperature, giving rise to bubble precipitation and gross swelling. This behavior is sensitive to the hyperstoichiometric composition of the material. Starting with a binder-free powder, a very small amount of carbon (of the order of 10 ppM) reacting with UO_2 to form carbon monoxide, may be responsible for the establishment of a microstructure, characterized by a distribution of the pores at the junction of the grains and a remarkable stability at high temperature. In these pores a gas pressure of the order of 10 atmospheres was estimated from gas analysis. (auth)

41647 ACTIVATED SINTERING OF UO_2 AND AN ATTEMPT AT ITS INTERPRETATION. Jakes, D.; Landspersky, H. pp 195-204 of Proceedings of the 2nd International Powder Metallurgy Conference, Stary Smokovec, Czechoslovakia, September 27–30, 1966. Present-Day Problems of Powder Metallurgy. Vol. I. Prague, Academia, 1966.

See CONF-660915(Vol.I).

For studying sintering and its activation, densities in the region of Tamman temperature of UO_2 (1200°C) were selected, where deformation on the densification curve in comparison with pure UO_2 can be expected. Admixtures causing melting were studied, namely VO, Nb_2O_5, CaO, Y_2O_3, and Al_2O_3. The most effective additives were Nb_2O_5 and Y_2O_3. Effects of Nb_2O_5 and VO are explained by applying the coefficient proposed by Bron under the following conditions: The uranyl niobates and vanadates are formed during the sintering that stabilizes the valency of the activating ion as well as that of U. The anion-vacancy mechanism is the predominant controlling mechanism at the temperature between 1100 and 1300°C, and the contribution of the formation of the liquid phase is considerably lower. For explanation of the influence of Y_2O_3 and CaO, Bron's theory may be used with the presumption that the additives stabilize the real activating components, U^{6+} or U^{5+}. The existence of these ions was proved analytically. The results correspond with those obtained in sintering UO_2 pellets in an oxidizing atmosphere. (P.C.S.)

41648 SINTERING KINETICS OF URANIUM DIOXIDE. Jakesova, L.; Podest, M. pp 205-17 of Proceedings of the 2nd International Powder Metallurgy Conference, Stary Smokovec, Czechoslovakia, September 27–30, 1966. Present-Day Problems of Powder Metallurgy. Vol. I. Prague, Academia, 1966.

See CONF-660915(Vol.I).

The microagglomerate state of initial UO_2-powder affects the activation energy of densification as proved by kinetic measurements. Difference in the specimens, defined by means of the coefficient, is not expressed as precisely as in the case of pressing or sintering correlations. In the initial stage of sintering and in the isothermal period of the heat treatment, different activation energies may be attached to the group of active and less active specimens. The calculated values of activation energies do not explain the densification mechanism. Results show the effects of hyperstoichiometric O_2 during the sintering of UO_2 in reducing atmosphere does not superimpose the influence of the initial structure of the powder on the sintering process. (auth)

41649 INTERDEPENDENCE BETWEEN CHARACTERISTIC QUALITIES OF UO_2 POWDERS AND SINTERABILITY. Stamenkovic, I. D.; Ristic, M. M. pp 219-27 of Proceedings of the 2nd International Powder Metallurgy Conference, Stary Smokovec, Czechoslovakia, September 27–30, 1966. Present-Day Problems of Powder Metallurgy. Vol. I. Prague, Academia, 1966.

See CONF-660915(Vol.I).

The influence of the characteristic parameters of UO_2 powders on their sinterability was investigated. Powders produced by various methods (UNH, ADU, and by oxidation and reduction of as received UO_2 powders) were used. Lanel's parameter was used as a measure of sinterability. It was found that sinterability is not a direct function of the specific surface (SP), the mean particle dia of as received powders and tap density. No connection exists between the sinterability and the mean particle dia of deagglomerated powders (d_v). By introducing the SP/d_v ratio, experiments showed that Lanel's parameter is a function of this value having the analytical expression $L = ae^{bx}$ valid for sintering temperatures 1100 to 1550°C. (auth)

Properties Evaluations

Refer also to abstracts 41642 and 41868.

41650 (IS-1600, Paper 1) CERAMIC AND MECHANICAL ENGINEERING DIVISION. Spedding, F. H.; Wilder, D. R.; Fisher, R. W.; Hunter, O. (Ames Lab., Iowa). 19p.

Developments are reported for studies on: diffusion of oxygen in Y_2O_3 and Er_2O_3; gadolinium glasses; high-temperature emissivity of oxides; single crystal diffusion in Y_2O_3, stoichiometry of Y_2O_3; emittance of uranium oxides; elasticity of some rare earth oxides; flash thermal diffusivity measurements of ceramic materials; melting point depression in U–Cr and U–Mn eutectics; corrosion of Ta and Y by U–Mn and U–Cr eutectics; corrosion of Y by molten U at 1200 to 1400°C; magnetic flowmeter calibration tests using Na in Inconel; effect of pump duct width on electromagnetic pumping performance; preferential diffusion of molten Zn through Mo. (P.C.H.)

41651 DIFFUSION OF ^{229}Th AND ^{233}U IN α-ALUMINA. Fiedler, W.; Bobleter, O. (Atominstitut der Oesterreichische Hochschule, Vienna). Atomkernenergie, 12: 357-60(1967). (In German).

The diffusion of ^{229}Th(IV) and ^{233}U(IV) in highly sintered alumina was investigated by alpha absorption in the temperature range between 1200 and 1500°C. The temperature dependence of the diffusion coefficients is given by the equations: ^{229}Th ... $D = (0.01 \pm 0.0075) \cdot \exp[-(63{,}900 \pm 2900)/RT]$ cm^2 sec^{-1}, ^{233}U ... $D = 17.4 \cdot \exp[-(99{,}800 \pm 5700)/RT]$ cm^2 sec^{-1}. (auth)

41652 ELECTRICAL PROPERTIES OF NONSTOICHIOMETRIC THORIUM CARBIDES. Auskern, A. B.; Aronson, S. (Brookhaven National Lab., Upton, N. Y.). Contract AT(30-2)-Gen-16. J. Appl. Phys., 38: 3508-14(Aug. 1967). (BNL-10976).

The resistivity, Hall coefficient, and thermoelectric power of ThC_x, with x varying from 0.787 to 0.91, were measured from 4.2 to about 400°K. The results were analyzed in terms of a two-band conductivity model. The analysis showed that as carbon is removed from the structure, band overlap increases and the number of carriers is increased. The resistivity data were analyzed using Matthiessen's rule and the analysis indicated that the residual resistivity arises from carbon vacancies. The vacancy contribution to the resistivity increases with increasing vacancy concentration. (auth)

41653 ADSORPTION OF HYDROCARBONS ON GRAPHITIZED CARBON. Hoory, S. E.; Prausnitz, J. M. (Univ. of California, Berkeley). Trans. Faraday Soc., 63: 455-60(Feb. 1967).

Experimental results are reported for monolayer adsorption of ethylene, ethane, propylene, propane, isobutane, and n-butane on homogeneous graphitized carbon. The data were reduced with a two-dimensional equation of state. Henry's constants, lateral interaction parameters, and heats and entropies of adsorption were calculated. The data indicate that for the larger hydrocarbons there is a decrease in rotational entropy of 2 to 4 cal/mole deg due to hindered rotation on the surface. The data also provide evidence for the conclusion that at normal temperatures hydrocarbons are adsorbed on graphitized carbon in a lying-down rather than in a standing-on-end position. (auth) (UK)

41654 ELECTROPHYSICAL PROPERTIES OF Gd, Tb, Dy, Er, AND Tm DICARBIDES. Paderno, Yu. B.; Yupko, V. L.; rud', B. M.; Kvas, O. F.; Makarenko, G. N. (Inst. of Material Science Problems, Kiev). Izv. Akad. Nauk SSSR, Neorg. Mater., 3: 395-7(Feb, 1967). (In Russian).

The electrophysical properties of GdC_2, TbC_2, DyC_2, ErC_2, and TmC_2 were determined experimentally. Initial powder carbides were obtained by the reduction of metal oxides with carbon in vacuum at 1800°C for 25 to 60 min. The carbide powders were compacted and sintered in Ar at 1700 to 1800°C for 15 min under a pressure of 100 kg/cm^2; the porosity of sintered compacts was 5 to 13%; finished specimens were annealed at 1650°C for 8 hr. It was found that carbide resistivity changed from 30 μ ohm c for GdC_2 to 515 μ ohm cm for TmC_2; the coefficient of emf from –5.95 μ v/°C for ErC_2 to –7.75 μ v/°C for TbC_2; Hall effect from –2.55 cm^3/coul for TbC_2 to +136 cm^3/coul for TmC_2; effective carrier concentration from 0.018 el/atom M for TmC_2 to 1.04 el/atom M for TbC_2; and mobility from 6.75 cm^2/v sec for ErC_2 to 19.6 cm^2/v sec for TmC_2. Melting points ranged from 2180°C for TmC_2 to 2280°C for ErC_2. (ATD)

41655 ELECTRICAL PROPERTIES OF NEODYMIUM TELLURIDE. Abrikosov, N. Kh.; Zargaryan, V. Sh. (Inst. of Metallurgy, Moscow). Izv. Akad. Nauk SSSR, Neorg. Mater., 3: 280-5(Feb, 1967). (In Russian).

Electric conductivity and thermoelectromotive force of NdTe, Nd_3Te_4, Nd_2Te_3, Nd_4Te_7, $NdTe_2$, and Nd_2Te_5 and solid solutions of Nd_3Te_4–Nd_2Te_3 were studied in the temperature range from 300 to 1300°K. The results showed that $NdTe_2$, Nd_2Te_5, and $NdTe_3$ have a positive conductivity and Nd_2Te_3 and Nd_4Te_7 a negative. Studies of Nd_3Te_4–Nd_2Te_3 solid solutions revealed a smooth transition from the Nd_2Te_3 compounds possessing semiconductor properties to Nd_3Te_4 with metallic properties. (R.V.J.)

41656 MECHANISM OF CONDUCTANCE IN DEFECTIVE NIOBIUM MONOCARBIDE LATTICES. Avgustinik, A. I.; Golikova, O. A.; Neshpor, V. S.; Ordan'yan, S. S. (Leningrad Tech. Inst. Semiconductor Inst., Moscow). Izv. Akad. Nauk SSSR, Neorg. Mater., 3: 286-90(Feb, 1967). (In Russian).

The Hall coefficient as a function of the nonstoichiometric composition of NbC in the homogeneity region, i.e., of compounds with the formula NbC_x, where x is smaller than unity, was investigated. On the basis of these measurements, it was found that the concentration of the current carriers would pass through a minimum for approximately the composition $NbC_{0.85}$. By determining the conductance as a concentration of the current carriers and also by measuring the thermal–emf in such defective NbC it was concluded that valence bonds Nb–C, and also valence Nb–Nb bonds, which occur more often as the defects in the carbon lattice become more pronounced exist. The presence of these latter bonds leads to a decrease of the effective mass of the current carrier which is clearly seen by the functional changes of the thermo–emf and by the slope of the curve which shows the electrical resistance as a function of the current carrier. (ATD)

41657 THERMAL EXPANSION OF SOME NIOBIUM CARBIDES. Kempter, C. P.; Storms, E. K. (Los Alamos Scientific Lab., N. Mex.). J. Less-Common Metals, 13: 443-7(1967).

The thermal expansion of the cubic compounds $NbC_{0.924}$, $NbC_{0.825}$, $NbC_{0.766}$, and $NbC_{0.702}$ was determined between 25° and 630°C by the Debye–Scherrer technique using gold as an internal standard. For the range 25° to 600°C the average linear thermal expansion coefficients (units of 10^{-6}/°C) are 6.2_3, 6.0_4, 6.0_2, and 5.8_9, respectively. (auth)

41658 SELF-DIFFUSION OF BERYLLIUM IN POLYCRYSTALLINE BERYLLIUM OXIDE. Condit, Ralph H.; Hashimoto, Yuriko (Univ. of California, Livermore). J. Amer. Ceram. Soc., 50: 425-32(Aug. 21, 1967). (UCRL-70166).

The self-diffusion of Be in polycrystalline BeO was measured from 1330 to 2135°C with the ^{7}Be tracer. Results are compared with other investigators; differences are due to variations in impurity and porosity contents. Diffusion was shown to be via a vacancy mechanism, with such impurities as Al and Si being the principal contributors of vacancies. Above about 1500°C the activation energy is no higher than 62 kcal, whereas it is 92 kcal at lower temperatures. It is suggested that this roll-over is due to Al impurity. There appears to be a temperature-independent anisotropy of diffusion, with the rate in the ⟨c⟩ direction being 30% higher than that in the ⟨a⟩ direction. It is concluded that the diffusion coefficient of Be in BeO above the roll-over temperature is governed by impurities and in this region it is given by the formula: $D = (1 + 20F_p)\, N_v(10 \times e^{-62.0\text{kcal/RT}})\ \text{cm}^2\ \text{sec}^{-1}$ where F_p is the fraction of porosity and N_v is the molar fraction of vacancies introduced by impurities. There is sufficient scatter in individual ⟨a⟩ and ⟨c⟩ diffusion values so that there is no value in discriminating between directions in this formula. (auth)

41659 STRENGTHENING HARD ALLOY BY A LIGHT RAY. Mirkin, L. I.; Pilipetskii, N. F. Izv. Akad. Nauk SSSR, Metal., No. 3, 137-9(May–June 1967). (In Russian).

Specimens of a hard tungsten carbide were exposed to a light ray generated by a laser. The energy of the pulse was 5 joules and its duration was about 10^{-3} sec. A crater about 1 mm deep and about 1 mm in diameter was produced in the specimen. It was found that due to the action of the light ray, the microhardness of the area adjacent to the crater changed from an initial 1300 kg/mm^2 to 2500 kg/mm^2. The increase in microhardness could have been caused by a transformation of WC into W_2C which is 1200 to 1400 kg/mm^2 harder, or the high-intensity light pulse could have caused deformation of the alloy, thereby hardening it. Hardening might also have been caused by the heat effect of the light ray. Actually, significant strengthening was observed only in alloys which can be strengthened by a phase transformation. The strength of pure metals, which undergo allotropic transformation (iron, aluminum, copper, tantalum, etc.), was hardly or not at all affected by the light ray. (ATD)

41660 AGE HARDENING OF NIOBIUM-BASE ALLOYS. Savitskii, E. M.; Dashevskaya, O. B. Izv. Akad. Nauk SSSR, Metal., No. 3, 152-8(May–June 1967). (In Russian).

The effect of alloying elements on the structure, phase composition, and properties of Nb-base alloys was investigated. Eight Nb-base alloys were melted from 99.8%-pure Nb, 99.5%-pure Mo, 99.5%-pure W, 99.0%-pure Zr, and spectrum-pure C. All the alloys contained 15% W and 15% Mo; Zr and C contents varied. Specimens of the alloys were deformed by hot forging. Hot deformation of these alloys was accompanied by aging, which changed their phase composition. Alloys containing 1 to 1.5% Zr age at 900 to 1100°C by forming oxide, nitride, and carbon phases. These alloys, in deformed and annealed state, are not suitable for long operation at high temperatures due to the coagulation and embrittling effect of oxide and nitride phases. Study of the combined effect of C and Zr (1.0 to 1.5%) on the structure and properties of Nb alloys showed that the rupture strength of these alloys can be increased by introducing 0.09 to 0.15% C. Annealing and aging of these alloys increased their rupture life 15 to 20 times. The optimal annealing and aging temperatures for Nb–W–Mo–Zr–C alloys were found to be 1700 and 1100°C, respectively. Nb-base alloys so treated can operate at 900 to 1100°C for up to 1500 hr without coagulation of phases or softening. It was concluded that Nb-base alloys working under a load for long periods of time at high temperatures should be hardened by a proper complex alloying in which their heat-resistance is taken into consideration, age-hardened by annealing and aging, and strengthened by deformation to obtain the necessary ductility by reducing the grain size. (ATD)

41661 EFFECT OF CARBON ON STRUCTURE AND STRENGTH CHARACTERISTICS OF NIOBIUM AND ITS ALLOYS. Malashenko, I. S. Izv. Akad. Nauk SSSR, Metal., No. 3, 159-66 (May–June 1967). (In Russian).

The microstructure and mechanical properties of Nb alloys containing 0.1, 0.15, or 0.20% C, or 16.5% W and 0.1 or 0.15% C, or 16.5% W, 0.5 Zr, and 0.1% C were investigated. Alloys were electron-beam melted from Na-reduced Nb and 99.98% to pure W and Zr and tested in the as-cast or heat-treated condition. The structure of Nb–C alloy consisted of a homogeneous solid solution containing particles of carbide phase which was identified as Nb_2C carbide with a hexagonal structure. No complex carbides were found in ternary Nb–W–C system. The strength of as-cast Nb–C alloys increased with increasing C content and reached a maximum of about 23 kg/mm^2 at 0.10% C, but the ductility dropped. With further increases in C content, both the strength and ductility decreased. Alloy with 0.10 to 0.15% C was forged with 80% reduction at 1000°C without cracks; alloy with 0.20% C, at the same or higher temperature, was unworkable. In Nb–W–C alloys a maximum strength of 50 kg/mm^2 was reached at 0.10% C, at which the elongation dropped to 2 to 5%. The addition of 0.5% Zr increased the elongation to 10%. 1250°C was the minimum temperature required for deformation of Nb–W–C alloy. Nb–C and Nb–W–C alloys with 0.10% C, vacuum-annealed at 1150 and 1400°C, respectively, for 2 hr, had a tensile strength of 30.0 and 58.0 kg/mm^2 an elongation of 27.0 and 18.7%. Nb–W–Zr–C alloy with 0.10% C had a tensile strength of 70.0 kg/mm^2 and an elongation of 27.8%. The effects of alloying became, especially pronounced at high temperatures. (ATD)

41662 DISSOCIATION OF TUNGSTEN CARBIDE IN A LOW-TEMPERATURE PLASMA FLUX. Panfilov, S. A.; Tsvetkov, Yu. V.; Chizhikov, D. M. Izv. Akad. Nauk SSSR, Metal., No. 3, 66-73(May–June 1967). (In Russian).

Dissociation of WC in a low-temperature Ar plasma jet was studied as a function of the mean-mass temperature and of the content of WC powder. The WC disintegrated in a plasma jet at

temperatures exceeding 4000°K forming W_2C and W. At higher temperatures the disintegration increased proportionately. The disintegration depended greatly on the method of powder injection into the jet. Carbothermal reduction of tungsten oxides in a plasma jet produced metals without the carbide phase. (R.V.J.)

41663 INVESTIGATION OF SOME PROPERTIES OF CARBIDES OF TRANSITION METALS OF THE 4TH AND 5TH GROUP AND PHASE ANALYSIS OF THEIR ALLOYS. Kotlyar, E. E.; Nazarchuk, T. N. pp 125-44 of Proceedings of the 2nd International Powder Metallurgy Conference, Stary Smokovec, Czechoslovakia, September 27–30, 1966. Present-Day Problems of Powder Metallurgy. Vol. II. Prague, Academia, 1966. (In Russian).

See CONF-660915-(Vol.2).

Studies on the chemical stability of transition metal carbides of groups IV and V in oxidizing acids, in a mixture of acids with oxidants, and in mixture of oxidants with complexing agents showed that the stability of group IV diminished with increasing atomic number from TiC to HfC and in group V it increased with atomic number from VC to TiC. The data obtained were used in the chemical analysis and phase diagrams of carbide mixtures and ZrO_2–ZrC, ZrO_2–TiC, and ZrO_2–NbC systems. (R.V.J.)

41664 STUDY OF THE MECHANICAL PROPERTIES OF HIGH-COBALT CEMENTED TUNGSTEN CARBIDES. Tu, K. N.; Garland, J. pp 145-58 of Proceedings of the 2nd International Powder Metallurgy Conference, Stary Smokovec, Czechoslovakia, September 27–30, 1966. Present-Day Problems of Powder Metallurgy. Vol. II. Prague, Academia, 1966.

See CONF-660915-(Vol.2).

The mechanical properties of WC–Co alloys with 50, 60, and 70% Co were studied. The fracture strength and hardness were found to increase with decreasing particle size of WC. The scatter of the experimental data precludes a definite check on a particular strength theory, but the data are not in disagreement with the concept that particle dia is the governing variable over most of the range. (J.G.B.)

41665 X-RAY STUDY OF STRESSES IN SINTERED WC–Co SYSTEMS. Chekh, V.; Kraus, I. pp 159-70 of Proceedings of the 2nd International Powder Metallurgy Conference, Stary Smokovec, Czechoslovakia, September 27–30, 1966. Present-Day Problems of Powder Metallurgy. Vol. II. Paris, Academia, 1966. (In Russian).

See CONF-660915-(Vol.2).

Results are given of x-ray studies on thermal stress and surface layer stress in a carbide phase during bending tests carried out with sintered WC–Co specimens containing from 6 to 25 wt % cobalt and prepared from WC powder with mean grain dimensions of 1 and 3 μ. (R.V.J.)

41666 SINTERING OF ZIRCONIUM DIBORIDE AND ITS ALLOYS WITH MOLYBDENUM AND MOLYBDENUM DISILICIDE. Kislyi, P. S.; Kuzenkova, M. A. pp 191-201 of Proceedings of the 2nd International Powder Metallurgy Conference, Stary Smokovec, Czechoslovakia, September 27–30, 1966. Present-Day Problems of Powder Metallurgy. Vol. II. Prague, Academia, 1966. (In Russian).

See CONF-660915-(Vol.2).

Relative changes in the structure of ZrB_2 under isothermal heating at 1550°C and at constant heating at the rate of 7 to 10 deg./min in the temperature range from 1800 to 1900°C were studied. The two-phase ZrB_2 exhibited considerable shrinkage while shrinkage in single-phase ZrB_2 was much smaller. The specimens sintered under isothermal conditions contracted rapidly during the initial 20 to 30 min reducing the porosity of the material 50 to 20%. Additions of Mo reduced the strength of the lattice bond and also reduced the microhardness. At 1000°C the specimen began to grow. A more rapid rate of dimensional growth and maximum size were found in specimens containing 5% Mo. Specimens of ZrB_2 with 15% $MoSi_2$ revealed considerable growth at 1800°C, reaching more than 8% and followed by an intense shrinkage. (R.V.J.)

41667 DIFFUSION OF OXYGEN IN NEAR-STOICHIOMETRIC α-Nb_2O_5. Chen, W. K.; Jackson, R. A. (Argonne National Lab., Ill.). J. Chem. Phys., 47: 1144-8(Aug. 1, 1967).

O_2 diffusion coefficients have been determined for near-stoichiometric α-Nb_2O_5 over the temperature range of 850 to 1200°C and the oxygen pressure range of 10^{-2} to 1 atm. At a constant temperature, the diffusion coefficient is found to be proportional to $p_{O_2}^{1/6}$. Temperature dependence of the diffusion coefficient at a constant O_2 pressure is expressed (in square centimeters per second) by $D = 1.72 \times 10^{-2} \times \exp[-(49.4 \pm 3.3 \text{ kcal/RT}]$. Results are discussed in terms of an O_2-vacancy model of nonstoichiometric disorder. (auth)

41668 Cr–Si–W ALLOY POWDERS FOR VACUUM METALLIZING IN THE PRODUCTION OF RESISTORS. Waltenberger-Razniewska, M.; Bukowiecki, J. pp 15-23 of Proceedings of the 2nd International Powder Metallurgy Conference, Stary Smokovec, Czechoslovakia, September 27–30, 1966. Present-Day Problems of Powder Metallurgy. Vol. I. Prague, Academia, 1966. (In German).

See CONF-660915(Vol. I).

Production of thin layers of the Cr–Si type on ceramic surfaces was investigated to find a relation between the characteristics of the powder and of the prepared layers. Dependence of the electrical characteristics of the layer on chemical composition was observed. The effects of grain fraction of the powder selected were considered. (M.C.G.)

Structure and Phase Studies

Refer also to abstract 41575.

41669 CRYSTALLOGRAPHIC STUDY OF THE Er–Se SYSTEM. Guittard, Micheline; Flahaut, Jean (CNRS, Paris). Compt. Rend., Ser. C, 264: 1951-4(June 12, 1967). (In French).

Five phases were identified in the Er–Se system. The first, of the NaCl type, forms a homogeneity range on both sides of the ErSe composition (between $ErSe_{0.75}$ and $ErSe_{1.1}$). The three succeeding phases are superstructures of the preceding lattice more and more deformed as it is removed from the ErSe composition. These are: $ErSe_{1.20-1.25}$ of unidentified structure; $ErSe_{1.29-1.33}$ rhombohedric structure of the type Yb_3Se_4; $ErSe_{1.45-1.50}$ orthorhombic of the Se_2S_3 type. Finally the fifth phase, which is connected to the series of polyselenides, has the composition Er_4Se_7 and is a superstructure of Fe_2As. (tr-auth)

41670 URANIUM–PLUTONIUM–OXYGEN TERNARY PHASE DIAGRAM. Markin, T. L.; Street, R. S. (Atomic Energy Research Establishment, Harwell, Eng.). J. Inorg. Nucl. Chem., 29: 2265-80(Sept, 1967).

The U–Pu–O phase diagram was constructed between $UO_{1.65}$–U_3O_8 and PuO_2–$PuO_{1.5}$ for all concentrations of Pu and between room temperature and 800°C, from results obtained using a high-temperature x-ray powder diffraction camera, together with the results of other workers. The general formula of single-phase material is $U_{1-z}Pu_zO_{2\pm x}$. Reduction of oxides having $z > 0.4$ to a sub-stoichiometric composition results in the formation, at room temperature, of two phases of composition $MO_{2.0}$ and MO_{2-x}. On heating this two-phase product a single phase was formed at a temperature dependent on the value of z. Reduction of oxides when $z < 0.4$ resulted in single-phase material at all temperatures. Partial oxidation when $z < 0.5$ resulted in either a single phase, fcc MO_{2+x} or the MO_{2+x} phase in equilibrium with an M_4O_9-type phase. Further oxidation caused the disappearance of the MO_{2+x} phase; the M_4O_9-type phase was then in equilibrium with a M_3O_{8-y} phase. (auth) (UK)

41671 THE CRYSTAL STRUCTURE OF Pb_3UO_6. Sterns, Meta (Australian National Univ., Canberra). Acta Crystallogr., 23: 264-72(1967).

The structure of Pb_3UO_6 was determined from single-crystal data, by analysis of the three-dimensional Patterson distribution, Fourier and ΔQ syntheses, and subsequent block-diagonal least-squares refinement to a final R value of 0.068. The unit cell is orthorhombic, space group Pnam, with a = 13.71, b = 12.36, c = 8.21 Å and Z = 8. The uranium atoms are octahedrally coordinated to six oxygen atoms and the slightly distorted octahedra, by sharing apices, form infinite staggered chains in the z direction, the lead atoms and the remaining oxygen atoms being distributed in a rather irregular array between the chains. (auth) (DENMARK)

41672 NEW COMPOUNDS WITH STRUCTURE OF THE TYPE $W_2Cr_{21}C_6$. Kuz'ma, Yu. B.; Voroshilov, Yu. V. (Lvov State Univ.). Sov. Phys.-Cryst. (Engl. Transl.), 12: 297-8 (Sept.-Oct. 1967).

Translated from Kristallografiya, 12: 353(Mar.-Apr. 1967).

Samples of the ternary systems R–Co–B and R–Ni–B (R = Sc, Ti, V, Mn, Nb, Hf, Ta) were prepared by sintering prepressed powders of the starting materials in vacuo at 1200°C. X-ray-diffraction analysis showed that ternary compounds having a cubic structure of the type $W_2Cr_{21}C_6$ were formed for all systems studied. Lattice constants are tabulated and positions of the R atoms are discussed. (A.G.W.)

41673 MAGNETIC STRUCTURE OF THE PEROVSKITE-TYPE CRYSTALLINE COMPOUND: $TbAlO_3$. Bielen, J.; Mareschal, J.; Sivardiere, J. (CEN, Grenoble, France). Z. Angew. Phys., 23: 243-5(1967). (In German).

$TbAlO_3$ forms a deformed Perovskite structure, which was in-

vestigated by neutron diffraction methods. The Neél temperature lies at about 4°K. Below this temperature the terbium forms a substructure with noncollinear antiferromagnetic order. At 1.5°K the spin configurations belonging to the Γ_5 formation were observed. These are: $G_x(+-+-) = 6.9\ \mu_B$ and $A_y(+--+) = 4.6\ \mu_B$ with a total moment of $M = 8.25\ \mu_B$. Similar results were found for the compounds $ThFeO_3$ and $ThCrO_3$ crystallized in the same Perovskite lattice type; according to the results this order has a dipolar origin. (tr-auth)

41674 STRUCTURAL DEPENDENCE OF THE TRACER-LEVEL DIFFUSION OF THORIUM IN PYROLYTIC CARBONS. Lonsdale, H. K.; Graves, J. N. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Contract AT(04-3)-167. J. Appl. Phys., 38: 3620-9(Aug. 1967). (GA-7515).

Tracer-level diffusion studies have been carried out on laboratory-prepared samples of pyrolytic C of widely divergent microstructure. These samples are well characterized and contain no exposed layer-plane edges. Using a ^{228}Th tracer, diffusion coefficients have been measured perpendicular to the plane of deposition over the temperature range 1600 to 2000°C. The diffusion coefficients were found to have a significant dependence on microstructure, the diffusion coefficient in a highly oriented, laminar pyrolytic C being more than an order of magnitude smaller than that in either isotropic or granular carbons. The diffusion coefficient D, in cm^2/sec, of Th perpendicular to the plane of deposition in granular, isotropic, and laminar pyrolytic carbons is given. The tracer-level diffusion coefficients for thorium in the laminar pyrolytic C were substantially smaller than the values that have been reported by others for diffusion in highly anisotropic, columnar pyrolytic C. Microstructural parameters, such as apparent crystallite size and anisotropy factor, are useful in correlating the present results but are of limited value in quantitatively rationalizing the large variations in diffusion coefficients. Measurements of the tracer-level diffusion coefficient of Th in a polycrystalline graphite were also performed. (auth)

41675 STUDIES OF THE NbO_2–Nb_2O_5 SYSTEM. Kovba, L. M.; Trunov, V. K.; Pol'shchikova, Z. Ya. (Moscow State Univ.). Izv. Akad. Nauk SSSR, Neorg. Mater., 3: 403-5(Feb. 1967). (In Russian).

Phase studies on the NbO_2–Nb_2O_5 system revealed that in the interval between $NbO_{2.454}$ and $NbO_{2.474}$ a phase of varying composition existed that was crystallographically close to the phases of $TiNb_{24}O_{64}$ and $ZrO_2 \cdot 7Nb_2O_5$. The lattice parameters for the $NbO_{2.454}$–$NbO_{2.474}$ phases were found for two different compositions. Indexed x-ray data for $NbO_{2.467}$ are tabulated. (R.V.J.)

41676 DIELECTRIC PROPERTIES OF STRONTIUM TITANATE SOLID SOLUTIONS CONTAINING NIOBIA. Tien, T. Y.; Moratis, C. J. (Westinghouse Research Labs., Pittsburgh). J. Amer. Ceram. Soc., 50: 392-4(Aug. 21, 1967).

$SrTiO_3$ solid solutions containing $Sr_{0.5}NbO_3$ were studied by x-ray diffraction and dielectric measurements. Single-phase perovskite solid solutions were formed up to the composition containing 30 mole % $Sr_{0.5}NbO_3$. The addition of Nb resulted in a symmetry change from cubic ($SrTiO_3$) to tetragonal (solid solution) and the c/a ratio increased with increasing Nb content. The dielectric constant for the solid solutions was lower than that for $SrTiO_3$. Pronounced dielectric relaxation peaks and dispersion in permittivity were observed for the composition, $7SrTiO_3 : 3Sr_{0.5}NbO_3$. The activation energy for the relaxation process is about 0.42 eV. It is suggested that the existence of the A-site vacancy in the perovskite ABO_3 lattice introduced by the Nb substitution distorts the O octahedra, producing more than one possible "noncentral" site for the Ti^{4+} ion. The relaxation arises from the thermal motion over potential barriers separating these alternative sites. (auth)

41677 PHASE TRANSITION IN THE SYSTEM Ca_3WO_6–Sr_3WO_6. Chang, Luke L. Y.; Phillips, Bert. J. Amer. Ceram. Soc., 50: 434-5(Aug. 21, 1967).

The stability of the cubic phase in the system Ca_3WO_6–Sr_3WO_6 was determined. A single phase was formed in all intermediate compositions at 400 to 1400°C. Because of the phase transition to the cubic structure is not quenchable, distinct splitting of several major peaks in the x-diffraction patterns was always obtained. Splitting decreased as the temperature increased, Sr_3WO_6 had less distortion than Ca_3WO_6 with the least distortion produced by compositions with nearly equal amounts of the end-members. No two-phase region was detected. Phase transition near the Ca-rich end was not determined because of the high temperatures involved, but it appeared that a transition in Ca_3WO_6 would not occur before melting. (P.C.S.)

41678 NEUTRON-DIFFRACTION STUDY OF UC_2 AT 300° TO 5°K. Atoji, Masao (Argonne National Lab., Ill.). J. Chem. Phys., 47: 1188-9(Aug. 1, 1967).

A neutron-diffraction study was made using a higher precision and a purer sample of $UC_{1.86}$ (99.6% pure with 0.4% free carbon) than in previous measurements. Crystal-structure data obtained at 300 and 5°K are tabulated. Significant differences between previous and present data were found. A search for a phase transition between 300 and 5°K yielded negative results. In spite of a large uncertainty in the neutron magnetic analysis, it is considered likely that the magnetic susceptibility retains its temperature independence down to near 0°K. (A.G.W.)

Radiation Effects

41679 (BNWL-225) ATLAS OF IRRADIATED FUEL STRUCTURES. Horn, G. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct. 1966. Contract AT(45-1)-1830. 93p. Dep. CFSTI.

Photomosaics, photographs, and autoradiographs presented for irradiated fuel specimens were obtained by conventional hot-cell ceramographic techniques. Fuel specimens include: urania, plutonia–urania, plutonia–thoria, and magnesium oxide–plutonia. (D.C.C.)

41680 INVESTIGATION OF NEUTRON IRRADIATION ON THE STRUCTURE OF PYROCERAMICS. Brekhovskikh, S. M.; Grinshtein, Yu. L.; Kim, E. I.; Sinyaya, L. V.; Shelyubskii, V. I. Izv. Akad. Nauk SSSR, Neorg. Mater., 3: 1474-8(Aug. 1967). (In Russian).

Studies of neutron radiation effects on the structure and phase composition of transparent C-343 and opaque IV-23 pyroceramics showed that neutron radiation with doses up to 10^{19} n/cm^2 reduced the crystalline phase content or induced changes similar to those caused by increased temperature. (R.V.J.)

41681 RARE-GAS MOBILITY IN SOME ANISOTROPIC CERAMIC OXIDES: Al_2O_3, Cr_2O_3, Fe_2O_3, TiO_2, U_3O_8. Matzke, Hj. (Technical Univ., Brunswick). J. Mater. Sci., 2: 444-56(Sept. 1967).

The mobility of the inert gases Xe or Rn in five anisotropic oxides (hexagonal corundum Al_2O_3, Cr_2O_3, Fe_2O_3, tetragonal rutile TiO_2, and orthorhombic U_3O_8) was studied. The gases were introduced by ion bombardment. The oxides were in the form of powders, sinters, or single crystals. Normal volume diffusion was found at low gas concentration, the activation energies in kilocalories per mole being ≥85 for Al_2O_3, 73 ± 5 for Cr_2O_3, 68 ± 5 for Fe_2O_3, 78 ± 5 for TiO_2, and 85 ± 8 for U_3O_8, and the pre-exponential terms D_0 falling into the "ideal" range of about $3 \times 10^{-1\pm1}$ cm^2/sec. Structural radiation damage, the annealing of which coincided with gas release at low temperatures, and, in some cases, retardation of the gas release, were found at higher gas concentrations. Some evidence is presented that grain boundaries, pre-existing vacancy clusters, and dislocation loops may act as trapping sites for gas atoms (or bubbles) and may be stabilized after trapping of the gas. (auth)

41682 GAS RELEASE FROM IRRADIATED BERYLLIUM OXIDE AND BORON CARBIDE DURING ISOTHERMAL ANNEALING. Davidov, E. F.; Zavidovskii, V. Ya.; Sochilin, G. I.; Syuzev, V. N.; Chushkin, Yu. V. At. Energ. (USSR), 22: 501-3 (1967). (In Russian).

The release of gases from irradiated BeO and B_4C was investigated on specimens of annealed, dispersed BeO and B_4C powders, using natural B. The compacted powdered specimens, possessing 20% porosity were exposed to an integral flux of 8×10^{20} thermal neutrons per cm^2 at a temperature not exceeding 200°C while placed in stainless steel tubes. The ^{10}B amounted to 80%. The tubes were pierced in a hot cell to determine the amount of gas releases during annealing at temperatures raised gradually to 1100°C. Comparison with unirradiated specimens revealed that the small amount of adsorbed gases may be neglected. It was found that 70% of the gases was released from the BeO within 250 to 300°C; the remaining 30% was released within the 700 to 900°C range. In the case of B_4C, the release started at 400°C and reached its maximum between 400 and 500°C. The diffusion equation controlling the process is quite complex; the derivative dV/dT was found to be proportional to the factor $e^{-H/kT}$. The observed behavior was explained on the basis of the so-called trap mechanism, assuming that there are local defects in the two materials. These defects may be originated during the preparation and during the irradiation. They act as centers or "traps" for the release of the gas atoms at the grain surfaces where the energy of activation is highest. This was verified by electron paramagnetic resonance studies of BeO during various stages of annealing. (TTT)

41683 IRRADIATION-INDUCED STRESSES IN SOLID SEMI-INFINITE AND SHORT GRAPHITE CYLINDERS SUBJECTED TO AN AXISYMMETRIC AXIAL FLUX GRADIENT. Shaw, W. A. (Auburn Univ., Ala. Oak Ridge National Lab., Tenn.); Yahr,

G. T.; Witt, F. J. Contract W-7405-eng-26. Nucl. Eng. Design, 5: 391-404(July 1967). (ORNL-P-2908).

A solid semi-infinite or short graphite cylinder subjected to a fast neutron irradiation flux which decays exponentially along the axis of the cylinder is analyzed. The dimensional changes produced in graphite by fast neutron irradiation are mathematically identical to the dimensional changes produced by a change in temperature. The analysis is for the isotropic elastic case; however, the irradiation shrinkage coefficients may differ in the axial and in-plane directions. A modified Love stress function is used in conjunction with the body force analogy to obtain a solution well away from the ends of the cylinder. The complete solution is obtained by superposing onto this solution the solution for the cylinder with applied end stresses equal to but opposite in sign to the non-zero axial and shear stresses given at the ends by the infinite cylinder analysis. The solution of the end problem is obtained by using the Love stress function in conjunction with the boundary conditions on the curved surface. This procedure yields a complex eignnvalue series solution with arbitrary constants and the series is truncated in actual application. The arbitrary constants are determined by least squares fitting the boundary conditions on the end surface at many points. It is shown in an example that a satisfactory solution may be obtained using only a few terms of the series. (auth)

Plastics and Other Materials

Refer also to abstract 41098.

41684 (AD-645765) RADIATION EFFECTS ON ELECTRONIC PARTS AND MATERIALS. Quarterly Report No. 7, June 15-September 14, 1966. Frankovsky, Frank A. (International Business Machines Corp., Owego, N. Y. Electronics Systems Center). Dec. 1966. Contract DA-28-043-AMC-02374(E). 23p. (ECOM-02374-1). CFSTI.

A series of radiation tests has been completed on mica, Mylar, and polystyrene dielectrics at the Physics International Advanced Flash X-Ray Facility. Capacitors were tested to measure the induced current and replenishment charge as a function of voltage, dose rate, and temperature. Data analysis is not complete; however, relative observations are presented for each dielectric exposed to the short pulse and high radiation level. (auth)

41685 (BNWL-SA-1161) INFRARED TESTING OF BONDS BETWEEN GRAPHITE AND PROTECTIVE COATINGS. Green, Donald R.; Day, Clifford K. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). [1966]. Contract AT(45-1)-1830. 30p. (CONF-670605-4). DTIE.

From 70th Annual Meeting of the American Society for Testing and Materials, Boston, Mass.

A method for nondestructive testing of bonds between graphite and protective coatings is given. This is an emittance-independent digital infrared method. Results are compared with metallographic destructive analysis. A description of the equipment is given. Use of a thermal wave transducer for nondestructive measurements is also discussed. (M.L.S.)

41686 (KAPL-P-3367) USE OF RTV SILICONE RUBBER AND EPOXY RESINS FOR THE REPLICATION OF IRRADIATED TEST SAMPLES. Tranter, L. E. (Knolls Atomic Power Lab., Schenectady, N. Y.). July 5, 1967. Contract W-31-109-eng-52. 13p. (CONF-671102-13). Dep. CFSTI.

For Presentation at 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill.

The properties of room temperature vulcanizing 60 silicone rubber for use in the replication of irradiated test samples are described. The properties include easy mixing, short pot life, and the fact that it is unaffected after repeated positive casting. The equipment and procedure used are described. The use of epoxy for replication of irradiated test samples is also discussed. Dangers in handling both materials are listed. (P.C.H.)

41687 OXIDATION PITTING OF PYROLYTIC GRAPHITE AND VITREOUS CARBON. Blackman, L. C. F. (British Coal Utilisation Research Association, Leatherhead, Eng.). Carbon, 5: 196-7(Apr. 1967).

The similarities between oxidation pits in two different materials after reaction in flowing air and CO_2 are presented. The effects of surface impurities, temperature of deposition, and annealing are discussed. (UK)

41688 TIME DEPENDENCE IN THE ABLATION OF ZTA GRAPHITE IN FLOWING CO_2. Ladd, I. R.; Wilson, H. W. Jr.; Walsh, P. N. (Union Carbide Research Inst., Tarrytown, N. Y.). Carbon, 5: 195-6(Apr. 1967).

The rate of oxidation of ZTA graphite by CO_2 was studied in the arc-image stagnation-flow reactor. Rates were measured by before-and-after thickness measurements, and also by the use of a time-lapse camera-microscope. The flow of CO_2 at 400 torr stagnation pressure was varied in the range 500 to 10,000 cm sec^{-1}, and results are shown at 1690°, 1900° and 2430°K. The temperature dependence of the ZTA-CO_2 reaction was found to be similar to the PG-CO_2 reaction, with a maximum and minimum in the range studied, but the ZTA surface receded faster. A mechanism in accordance with the results is suggested. (UK)

41689 INTERACTION OF GRAPHITE FRESH SURFACE WITH DIFFERENT GASES AND VAPOURS. Zarifyanz, Yu. A.; Kiselev, V. F.; Lezhnev, N. N.; Nikitina, O. V. (Moscow State Univ.). Carbon, 5: 127-35(Apr. 1967).

Adsorption isotherms and heats of adsorption of O_2, CO, CO_2, NO, NO_2, N_2O, water, n-butane, butene-1 and isoprene were studied on the surface of freshly cleft graphite. It is shown that CO and CO_2 partly inhibit oxidation. Low-temperature adsorption of O_2 on the graphite fresh surface was studied, and it was shown that the temperature boundary of physical and chemical adsorption of O_2 lies within −73°C and −43°C. The products of thermal decomposition of surface oxides formed by the interaction of O_2 with the graphite fresh surface were analyzed. The interaction of the fresh surface with non-saturated hydrocarbons is accompanied by the break-up of a double bond in the molecule and by the formation of a free radical. It has been ascertained by a study of ESR spectra and by magnetochemical measurements that the major quantity of active centers on the graphite fresh surface is not comprised of free radicals. Possible change in the C peripheral atom valency in the course of crushing of graphite is discussed. (auth)

41690 NEUTRON SPECTRA NEAR TO A TEMPERATURE DISCONTINUITY IN GRAPHITE. Day, D. H. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Energy, 21: 713-32(Sept. 1967).

Neutron spectra were measured by the time-of-flight method, using a chopper, in a large graphite stack on either side of a sharp temperature discontinuity. Simple two-Maxwellian group diffusion calculations or multigroup transport calculations using realistic or heavy gas (Mass 30) scattering kernels gave good agreement with experiment. Considerable effects were observed due to the variation in neutron mean free path with the graphite extrusion direction. (auth)

41691 DIMENSIONAL CHANGES INDUCED IN PYROLYTIC CARBON BY HIGH-TEMPERATURE FAST-NEUTRON IRRADIATION. Bokros, J. C.; Price, R. J. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Contract AT(04-3)-167. Carbon, 5: 301-12(June 1967).

A variety of pyrolytic carbons with various densities, anisotropies, and microstructures, but with similar crystallite sizes, were irradiated at 600°, 1180°, 1330° and 1650°C to fast neutron exposures of 1.9, 2.6, 3.1 and 3.3×10^{21} nvt (E > 0.18 MeV), respectively. Changes in linear dimensions, density, apparent crystallite height, layer spacing, and anisotropy were measured. Significant changes in preferred orientation resulting from irradiation at temperatures above 1100°C were also measured. The Bacon anisotropy factor for many specimens increased more than 20 percent due to the irradiation. The kinetics of densification at 600°C were found to be first order with respect to the density defect and independent of the microstructural appearance of the carbon. At irradiation temperatures above 1100°C the densities of the carbons with initial densities less than about 2.06 g/cm^3 were increased by the irradiation, but the densities of those with initial densities greater than this value were decreased. The crystallite dimensional changes, $\Delta X_c/X_c$ and $\Delta X_a/X_a$, produced by irradiation, were derived from the measured dimensional changes parallel and perpendicular to the deposit and compared with the crystallite dimensional changes previously published for carbons and graphites with crystallite densities above 2.0 g/cm^3. The data show no dependence on crystallite size below ~500°C, where the mobility of radiation-induced point defects is low. Above ~500°C, where the mean diffusion distance of the displaced atoms is large compared with the crystallite size, dimensional change rates are higher for carbons with smaller crystallite sizes. (auth)

41692 THE CRYSTAL STRUCTURE OF $Nb_3Sb_2Te_5$. Jensen, P.; Kjekshus, A. (Oslo Univ.). J. Less-Common Metals, 13: 357-9(Sept. 1967).

The crystal structure and composition of a previously unknown phase of the Nb-Sb-Te system, $Nb_3(Sb,Te)_7$ was determined. The substance crystallizes cubically and has a density of 8.16 gcm^{-3}. The atomic structure indicates that it may be a semiconductor. (P.G.C.)

PHYSICS (GENERAL)

Astrophysics

Refer also to abstracts 41750, 41816, 41842, 41843, 41848, 41931, 42116, 42226, and 42679.

41693 (AD-636774) SOLAR MAGNETIC FIELDS. Technical Final Report, February 1, 1964-January 31, 1966. Cimino, Massimo (Rome Astronomical Observatory (Italy). Space Physics Research Center). Jan. 31, 1966. Contract AF61(052)-768. 14p. (AFCRL-66-522). CFSTI.

The research work was directed towards the following: (1) Perform necessary laboratory experiments, including a study on the Zeeman effect in absorption. Make observations of the sunspot and general magnetic fields of the sun. (2) Conduct a program of interpretation of the observations of solar magnetic fields. (3) Develop instrumentation as required for study of solar magnetic fields and associated solar phenomena. (4) Perform continous registration of chromospheric phenomena both in Ca II K and H-alpha lines, as indirect study of the solar magnetic fields. (auth) (TAB)

41694 (AD-645637) DESIGN NOTES ON AN INTERMEDIATE-RESOLUTION EXPERIMENT FOR THE MEASUREMENT OF THE ULTRASOFT X RADIATIONS OF THE SOLAR CORONA. Henke, Burton L. (Pomona Coll., Claremont, Calif. Dept. of Physics). Sept. 1966. Contract AF-AFOSR-689-64. 45p. (AFOSR-66-2446). CFSTI.

The report is a summary of notes on the design, calibration, and reduction of data for a series of rocket-borne, spectroscopic measurements of solar coronal x rays in the 15 to 45 A wavelength region. The measurements were made at solar activity minimum in May, July, and August of 1964 on the Nike-Tomahawk low altitude rocket systems. (auth) (TAB)

41695 (AD-647420) FINAL SCIENTIFIC REPORT, FEBRUARY 1, 1965-JANUARY 31, 1967. Haymes, Robert C. (Rice Univ., Houston, Tex. Dept. of Space Science). Jan. 31, 1967. Contract AF-AFOSR-858-65. 6p. (AFOSR-67-0410). CFSTI.

This report reviews the work which was aimed at measuring the spectrum of photons that have energies between 30 and 475 keV emanating from the Crab Nebula. A characteristic spectrum of line gammas was calculated on the basis of heavy-element synthesis in supernovae. A "gamma ray telescope" was designed, fabricated, and flown on balloons to search for this predicted radiation. The telescope is pointed in flight by a servo system. The results of the experiments are described. (auth) (TAB)

41696 (N-67-14203) ICARUS: INTER-PLANETARY CRAFT FOR ADVANCED RESEARCH IN THE VICINITY OF THE SUN. Charyulu, Varada P. (ed.) (Stanford Univ., Calif. School of Engineering). Aug. 1966. Contract NSR-05-020-151. 224p. (NASA-CR-80840). CFSTI.

A preliminary design study of ICARUS, an advanced solar probe, is presented. ICARUS will explore the region of space between 1 and 0.1 AU from the sun, both in and out of the ecliptic plane, and measure cosmic rays, solar particles, and magnetic fields. The major problem encountered in the spacecraft design was the 100-fold increase in solar radiation found at 0.1 AU. The spacecraft consists of a flat spin stabilized body of revolution with its axis normal to the orbit plane. This arrangement minimizes solar heat inflow and maximizes the heat rejected by radiation. The basic load carrying structure is beryllium and the fiberglass reinforced plastic outer shell is in the form of a frustrum of a cone. The solar cell power supply is on a flared conical skirt attached to the probe's bottom. It provides 40 watts near earth and 242 watts near the sun. Minimum heat inflow is achieved by optical solar reflectors and superinsulation. Travelling wave tubes provide communication data rates of more than 500 bits/sec. Data reduction and processing and analog to digital conversion are performed by a central data system in the spacecraft. (STAR)

41697 (UCRL-50224) EDDY TRANSPORT MAINTENANCE OF SOLAR DIFFERENTIAL ROTATION. Nickel, George Herman (California Univ., Livermore. Lawrence Radiation Lab.). Sept. 1, 1967. Contract W-7405-eng-48. 42p. Dep. CFSTI.

Thesis.

The differential rotation of the sun is interpreted as the largest axisymmetric mode of two-dimensional surface turbulence which is symmetric under reflection through the equatorial plane. The amplitude of this mode is determined by a balance of energy transport into the mode from smaller modes and energy dissipation by eddy viscosity. These smaller modes could be either photospheric turbulence or larger scale motions due to a horizontal instability which could arise if the solar equator were slightly warmer than the poles. Energy transport to large modes from small modes is a property of two-dimensional turbulence; an estimate is made for the maximum radial velocity of large scale motions in the convective zone for which the model is valid. A computer model of the nonlinear interaction of these two-dimensional modes verifies that energy can be transported to the differential rotation mode, and that the correlation of zonal and meridional velocities is in qualitative agreement with results obtained from sunspot observations. (auth)

41698 (NASA-TT-F-455) PROBLEMS OF ASTROPHYSICS. Fedorov, E. P. (ed.). Translation of Voprosy Astrofiziki, Izdatel'stvo, Naukova Dumka, Kiev, 1966. 168p. CFSTI.

Separate abstracts were prepared for sixteen of the seventeen chapters. One chapter was not in scope for Nuclear Science Abstracts. (W.D.M.)

For abstracts of individual chapters see: 41699-41714.

41699 (NASA-TT-F-455, pp 1-14) RESONANCE SCATTERING OF SOLAR RADIATION IN PROMINENCES. Yakovkin, N. A.; Zel'dina, M. Yu. Translated from Voprosy Astrofiziki, Izdatel'stvo, Naukova Dumka, Kiev, 1966.

It is shown that the prominences emit in the line H_α on account of the scattering of solar radiation. The proof is based on the solution of an integral equation for the case of fully incoherent scattering. Photospheric radiation in the line H_α enters into prominence and excites its glow in spite of the great optical thickness of the prominences in this line. The density of diffusion radiation is higher than the average density of the radiation entering into the prominence. The theoretical line profile under great optical thickness ($\tau \geq 10$) has a typical saddle shape. The central intensity and equivalent widths of the calculated line profile agree with the observations. (auth)

41700 (NASA-TT-F-455, pp 15-27) COMPARISON OF FAINT AND BRIGHT PROMINENCES. Morozhenko, N. N. Translated from Voprosy Astrofiziki, Izdatel'stvo, Naukova Dumka, Kiev, 1966.

As a result of analyzing hydrogen and metal lines, the values of the electron temperature, electron concentration, concentration of neutral hydrogen, and effective thickness in hydrogenous and metallic filaments of bright prominences are obtained. Owing to lack of data, it is possible in faint prominences to determine only the limits of the change of these values in hydrogenous filaments. The distinction in the spectra of faint and bright prominences may be explained by the difference in optical thickness, which is as high as 2 to 3 orders in the hydrogen and ionized calcium lines. (auth)

41701 (NASA-TT-F-455, pp 28-37) RESULTS DERIVED FROM SPECTROPHOTOMETRY OF SEVERAL PROMINENCES. Zel'dina, M. Yu.; Sergeyeva, A. N. Translated from Voprosy Astrofiziki, Izdatel'stvo, Naukova Dumka, Kiev, 1966.

Spectra were obtained for four bright prominences with a dispersion of 0.85 Å/mm. The kinetic temperature, Doppler half widths, and the population of the excited levels of atoms of hydrogen, helium, and metals are determined. (auth)

41702 (NASA-TT-F-455, pp 38-42) MECHANISM OF HYDROGEN EXCITATION IN PROMINENCE SURGES. Geychenko, M. S. Translated from Voprosy Astrofiziki, Izdatel'stvo, Naukova Dumka, Kiev, 1966.

The steady-state equations are solved for the 3rd, 4th, and 6th hydrogen levels of surges. The values of the electronic concentration are calculated. The mechanism of excitation of the 3rd, 4th, and 6th hydrogen levels in surges is photospheric radiation and radiative recombination. This is determined by the absolute magnitudes of the terms of these equations. (auth)

41703 (NASA-TT-F-455, pp 43-7) MECHANISM OF EMISSION BORDER FORMATION IN FILAMENTS. Kostik, R. I.; Orlova, T. V. Translated from Voprosy Astrofiziki, Izdatel'stvo, Naukova Dumka, Kiev, 1966.

Additional excitation of the chromosphere by photospheric radiation reflected from a filament is considered as one cause of emission border formation. A formula is obtained for estimating the border brightness. At the same time it explains the principal data (increase of border contrast at the center-limb passage, decrease of border intensity with filament height above the photosphere). The estimated values of the border brightness are in good agreement with the observations. (auth)

41704 (NASA-TT-F-455, pp 48-58) RESEARCH ON CALCIUM LUMINESCENCE IN A GREAT CHROMOSPHERIC FLARE. Alikaeva, K. V. Translated from Voprosy Astrofiziki, Izdatel'stvo, Naukova Dumka, Kiev, 1966.

Ionized calcium luminescence in the chromospheric flare of July 12, 1961, is considered. The central parts of the H and K line profiles are broadened by nonthermal random velocities, and in the wings by nonMaxwellian velocity distribution. The change in electronic density, temperature, and effective length of the calcium filaments with time is determined. (auth)

41705 (NASA-TT-F-455, pp 59-64) SPECTROPHOTOMETRY OF THE SUNSPOT OBSERVED ON JUNE 19, 1959. Zemanek, E. N.; Stefanov, A. P. Translated from Voprosy Astrofiziki, Izdatel'stvo, Naukova Dumka, Kiev, 1966.

The equivalent widths of 107 Fe I lines were measured in the region 6520 to 4870 Å. A curve of growth was constructed, and the physical parameters for the sunspot were derived: T_{ex} = 3640 ± 90°, N = $(25.2 \pm 6.8)10^{13}$, v = 3 km/sec. A graphic method is proposed for determining excitation temperature from the growth curve. The dependence of the equivalent widths of the lines on the strength of the magnetic field and the spot's position on the solar disk is shown by comparing them for four spots. (auth)

41706 (NASA-TT-F-455, pp 65-70) ON THE H_α LINE EXCITATION MECHANISM IN THE SOLAR CHROMOSPHERE. Kostik, R. I. Translated from Voprosy Astrofiziki, Izdatel'stvo, Naukova Dumka, Kiev, 1966.

The profiles of chromospheric H_α are estimated for certain heights above the photosphere. Photospheric radiation is regarded as a source of excitation. It is shown that both external and internal sources are almost equally responsible for the luminescence of the H_α line. The relative role of internal sources of excitation increases with the height above the photospheric level. (auth)

41707 (NASA-TT-F-455, pp 71-7) INFLUENCE OF DISSIPATION ON PLASMA EQUILIBRIUM IN A MAGNETIC FIELD. Shul'man, L. M. Translated from Voprosy Astrofiziki, Izdatel'stvo, Naukova Dumka, Kiev, 1966.

Plasma equilibrium conditions are formulated, taking into consideration dissipative processes. The electron thermo- and electroconductivity are specially considered. There are some cases when the investigation of dissipative plasma equilibrium can be reduced to the solution of some plane and one-dimensional problems. One-dimensional equilibrium configurations with a constant magnetic field gradient and constant density of matter are discussed. The effect of volume sources and energy loss is examined in the case when they predominate in the establishment of thermal equilibrium. (auth)

41708 (NASA-TT-F-455, pp 78-82) CHOICE OF THE PRE-FLARE PLASMA STATE MODEL. Shul'man, L. M. Translated from Voprosy Astrofiziki, Izdatel'stvo, Naukova Dumka, Kiev, 1966.

The problem of the pre-flare plasma state model is discussed. The pre-flare state has to be an equilibrium state up to very slow processes. It is shown that acoustic heating and radiation rapidly set up thermal equilibrium in the chromospherical plasma. Therefore, the models formerly proposed are incorrect unless they satisfy the thermal equilibrium conditions. (auth)

41709 (NASA-TT-F-455, pp 83-96) CONVECTIVE STAR MODEL WITH NON-RIGID ROTATION. Porfir'ev, V. V. Translated from Voprosy Astrofiziki, Izdatel'stvo, Naukova Dumka, Kiev, 1966.

It is proved that stationary rotation is characterized by a decrease of angular velocity and "equatorial slowing" down on the surface of a star in the presence of sufficiently developed circulation. It is shown that such a law of rotation is not observed in real stars; therefore, it is necessary to consider rotation without circulation. The equations of star structure in the absence of circulation are derived. In this case the law of rotation is determined by the distribution of temperature and density in the star. The law of rotation for a star with a convective core and a radiative envelope is given. The angular velocity of rotation increases slowly towards the surface. Distribution of the angular velocity on the surface of such a star is similar to that observed for the Sun. (auth)

41710 (NASA-TT-F-455, pp 97-102) CATALOG OF PHOTOGRAPHIC MAGNITUDES OF COMPARISON STARS IN GLOBULAR CLUSTER M92. Paneva, L. I.; Kheylo, E. S. Translated from Voprosy Astrofiziki, Izdatel'stvo, Naukova Dumka, Kiev, 1966.

A catalog of magnitudes of 278 stars in the neighborhood of the globular cluster M92 is contained. The value of the internal error is $\pm 0.02^m$. A transitional formula of the photometric system into the international one is given. (auth)

41711 (NASA-TT-F-455, pp 103-12) VARIABLE STARS IN GLOBULAR CLUSTER M92. Kheylo, E. S. Translated from Voprosy Astrofiziki, Izdatel'stvo, Naukova Dumka, Kiev, 1966.

The observations of six RR-Lyrae stars in M92 and the results of their evaluation are given. The periods are determined, and the variation of the period is found for one star. (auth)

41712 (NASA-TT-F-455, pp 113-27) CATALOG OF PHOTOVISUAL MAGNITUDES OF STARS IN THE REGION WITH CENTER $\alpha = 19^h$, $\delta = +11^0$. Voroshilov, V. I. Translated from Voprosy Astrofiziki, Izdatel'stvo, Naukova Dumka, Kiev, 1966.

A catalog is presented of photovisual magnitudes of 3440 stars, determined with a mean error of $\pm 0.04^m$. The International System is used in the catalog. (auth)

41713 (NASA-TT-F-455, pp 128-37) SPATIAL DISTRIBUTION OF STARS IN THE REGION WITH CENTER ($\alpha = 18^h50^m$, $\delta = +5^0$). Voroshilov, V. I. Translated from Voprosy Astrofiziki, Izdatel'stvo, Naukova Dumka, Kiev, 1966.

The structure of the Milky Way in the direction of the Sagittarius spiral arm and with the relation between the distribution of stars of different spectral types and the distribution of dust and neutral hydrogen are considered. All the O–B2 type stars detected are located in a region with a very low density of absorbing matter and neutral hydrogen. The B8–A5 and gF8–K5 type stars tend to group in the region of dust clouds. For F and G dwarfs, this tendency is slight. The study of star distribution in a direction perpendicular to the galactic plane shows that the density maxima of O, B, and A stars and late giants do not coincide with this plane. A partial picture is given of the structure of the Sagittarius spiral arm in Aquila. In order to obtain a more complete picture, observations of stars to 16^m in the region of the galactic equator and southern latitudes are necessary. (auth)

41714 (NASA-TT-F-455, pp 138-59) MILKY WAY IN THE CONSTELLATION AQUILA. Fedorchenko, G. L. Translated from Voprosy Astrofiziki, Izdatel'stvo, Naukova Dumka, Kiev, 1966.

The results are given of a study of the Milky Way in the Rift. The study was performed on the basis of magnitudes and spectra of stars up to 12.0^m to 12.5^m. The results of other investigations are used. The special features of dust and stellar components, their connection with one another and with neutral hydrogen are discussed. The link, consisting of early-type stars and dust clouds between the Carina–Cygnus and Sagittarius arms, is absent in longitudes, 340 to 20°, which is the main feature of the investigated galactic region. Some considerations are given as to the position of the Sagittarius arm in the Northern sky. (auth)

41715 YOUNGEST STARS. Herbig, George H. Sci. Amer., 217: 30-6(Aug. 1967).

A brief review is presented on the discovery, characteristics, and astrophysical implications of the T Tauri variables. (W.D.M.)

41716 MEASUREMENT OF THE ABUNDANCE OF ^{24}Na IN THE METEORITE SAINT-SEVERIN. Tobailem, Jacques; Nordemann, Daniel; David, Benjamin; Yokoyama, Yuji (CEN, Saclay, France. CNRS, Gif-sur-Yvette, France). Compt. Rend., Ser. D, 264: 2429-31(May 22, 1967). (In French).

^{24}Na, the cosmonuclide with the half life, 15 hr, was measured in the Saint–Severin meteorite (fallen June 27, 1966) by γ spectrometry. The activity found was 83 ± 25 dpm per kg of meteorite at the time of the fall. The contributions of the different production modes and the corresponding slow neutron flux were evaluated. (tr-auth)

41717 PHOTOSPHERIC TEMPERATURE DISTRIBUTIONS FROM CENTER-LIMB VARIATION OF CENTRAL INTENSITIES. Schmalberger, D. C. (Univ. of Rochester, N. Y.). Ann. Astrophys., 29: 255-62(May-June 1966).

The observational material for this study consisted of center-limb observations of 6 relatively weak lines of Ti(I), Fe(I), Fe(II), and Ni(I) in the 6100 to 6150 Å region of the Sun's photospheric spectrum. Center-limb variations of central intensities for these lines were used with a theoretical nongrey atmosphere and a model of anisotropic, depth-dependent microturbulence to derive their excitation temperatures and depths of formation. The resulting temperature distributions were within ±40°K of their mean and did not show the so-called fishbone effect to the degree which demonstrated the importance of nonhomogeneous structure in the photosphere. In an examination of reasons for its absence, the effect was found to be model dependent. It was concluded that inhomogeneous structure is not so important as to affect, through rugosity effects, the center-limb variation of central intensity. A tacit assumption involved in the fishbone effect analysis suggests the effect provides dubious evidence for photospheric nonlocal thermodynamic equilibrium and that: the center-limb variation of central intensity is negligibly influenced by inhomogeneous structure through rugosity effects. (BBB)

41718 MAGNETIC STARS. Ledoux, P.; Renson, P. (Univ. Liege, Belg.). Ann. Rev. Astron. Astrophys., 4: 293-352(1966).

Observational data relating to cosmic magnetic fields are

reviewed (with 303 references), which, in conjunction with magnetohydrodynamics and plasma physics, have led, apart from numerous interesting inferences and direct attempts at interpretation, to the development of a new class of problems in theoretical astrophysics. This review of data and ideas stressed the observational side, because it was felt that it is still the most basic aspect of the problems. Solar magnetic data and theories provide the most detailed information concerning the interaction, on a cosmic scale, of magnetic fields and plasmas. All the observations of stellar magnetic fields rest on the measurement of the longitudinal Zeeman effect in absorption lines. All the observed magnetic fields are subjected to variations on a time-scale of the order of days and with amplitudes of a few hundred to a few thousand gauss, leading, in more than half of the cases, to a reversal of the field. Some of these variations exhibit a definite periodicity; spectrum and luminosity variations of the same period are generally observed. The observed effects must be due to a field of more or less uniform intensity over the surface of the star. Properties of magnetic stars are discussed. The distinctive peculiarities of these stars reside in their spectra, in which the lines of elements such as Si, Cr, Mn, Sr, Y, Zr, and those of the rare earths are abnormally intense. Theories and inferences on stellar magnetism are examined. (BBB)

41719 SUPERDENSE STARS. **Wheeler, John Archibald (Princeton Univ., N. J.).** Ann. Rev. Astron. Astrophys., 4: 393-432(1966).

Properties of superdense stars and some recent concepts of their structure are reviewed. A superdense star is regarded as nuclear matter in bulk. At a temperature of less than $10^{8.5}$K, a superdense star is essentially cold in the sense that its properties (after the star burns, or is catalyzed, to the end point of thermonuclear evolution) are practically determined completely by a single parameter, the central density. So far no superdense star has been identified. Moreover, a so-called cool superdense star, with a radius of 10 Km, a surface temperature (after ~10^6 years of cooling) of $10^{6.6}$K, and at a distance of 10 pc, comparable to the distance of nearby stars, is fainter than the 19th magnitude and therefore hardly likely to be seen. The rapidity of cooling (details of which are described) makes detection even more difficult. Superdense stars may not have been seen in their maturity, still less in their old age; but their observability at the time of birth is possible. A star of perhaps 2 to 10 solar masses and density 10^7 or 10^8 g/cm^3 may gradually lose energy and contract. It becomes unstable against collapse, and undergoes a supernova explosion. Under appropriate conditions the explosion leaves behind a superdense core. This star vibrates, rotates, and radiates. The radiations include neutrinos, x rays, long-wavelength electromagnetic waves, and gravitational waves. All these features give hope that eventually it may be possible to observe a superdense star. Production of cosmic and x rays by superdense stars is discussed. The shock from a sudden pressure increase in the core intensifies as it advances outward into material of lower and lower density. By this mechanism, extreme relativistic energies are imparted to the outermost layers, containing 10^{-4} or 10^{-5} of the mass of the star. By the time this matter has encountered interstellar gas, it is already considered as a collection of independent cosmic rays, with the enormous penetrating power of relativistic particles. The calculated energy spectrum of these particles agrees in its general character with the observed cosmic ray spectrum. The discovery of x rays coming from localized cosmic sources, including the Crab Nebula, and the properties of these radiations are discussed. Both the shape of the spectrum and extent of the source show that the observed x radiation comes primarily from the filamentary part of the Crab Nebula rather than from a residual hot neutron star. This indicates that the main mechanism responsible for the radiation is the synchrotron process. (BBB)

41720 EMPIRICAL MODELS OF STELLAR ATMOSPHERES. I. INTRODUCTION AND PRELIMINARY APPLICATION. **Van't Veer, Frans (Institut d'Astrophysique, Paris).** Ann. Astrophys., 29: 7-16(Feb. 1966). (In French).

A model of the stellar (or solar) atmosphere is presented which offers a description of the variation of certain physical properties as a function of optical depth. It is pointed out that the exploitation of a solar or stellar spectrum is limited, on the one hand, by the physical interpretation of the different phenomena which gives rise to the formation of the continuum and of the absorption lines and on the other hand, by what is known of the physical constants which come into this interpretation. Attempts were made to establish a number of spectroscopic criteria which avoid these two difficulties, and which make possible comparison of certain stellar atmospheres by this simplified though empirical model atmosphere. The model is defined by a certain number of parameters, coefficients in formulas that are presented, which give temperature and gas and electron pressure as functions of optical depth. Application of this method requires high dispersion spectra on which equivalent widths and intensities in the wings of some tens of suitable lines can be measured. As a first example, comparison of a sunspot with the photosphere was made. (BBB)

41721 OBSERVATIONS OF SOLAR X-RAY ACTIVITY BELOW 20 ANGSTROMS. **Gregory, Bruce N.; Kreplin, Robert W. (Hulburt Center for Space Research, Washington, D. C.).** J. Geophys. Res., 72: 4815-20(Oct. 1, 1967).

Observations of solar x-ray emission in the wavelength regions of 1 to 8 and 8 to 16 Å were made by Explorer 30 (NRL SOLRAD 8). The analog real-time records show slowly varying changes of up to 40% in the 1 to 8 Å region with a time scale of 1 or 2 minutes and of 20% in the 8 to 16 Å region with a somewhat longer time scale. No fluctuations of more than 5 to 10% are observed within a time scale of 1 second, the highest time resolution of the satellite x-ray photometers. (auth)

41722 ORIGIN OF THE SOLAR WIND. **Samokhin, M. V.** Kosm. Issled. Akad. Nauk SSSR, 5: 305-6(Mar.-Apr. 1967). (In Russian).

It is assumed that in a spherical system of coordinates r, θ and ϕ having the polar axis directed along the angular velocity of the Sun ω and having the origin at the center of the Sun, the magnetic field B can be locally approximated by an Archimedian spiral: $B_r = B_0/r^2$, $B_\theta = 0$, and $B_\phi = -\omega B_0 \sin\theta/ur$. Here $B_0 = B_0(\theta)$ is an arbitrary function of the angle θ and u is the constant radial rate of expansion of the corona. The electric field E is given by the expression: $E = -(1/c)[uB]$. The plasma volume element is attached to a force line with a velocity $w = [\omega r]$, so that the velocity components w and u transverse to the magnetic force line are the same, $w_\perp = u_\perp$. Drift in the crossed electric and magnetic fields is the main mechanism of motion for particles of nonrelativistic energies. Since the fields do not depend on time, the energy is the integral of the motion, and the final drift equations assume a simple form. It is shown that the transverse velocity component of the proton $u_\perp$ does not depend on the initial velocity, while the longitudinal component $v_{||}$ is determined by the initial energy, and at large distances does not depend on the magnetic moment. For a low-energy proton the rate of motion is perpendicular to the magnetic force line, since the initial energy is converted into potential energy, while the rate of motion is along B for a high-energy proton. As would be expected, protons with an energy of 0.83 keV move radially (this energy corresponds to a velocity of 400 km/sec). (TTT)

41723 COMMISSIONING OF A RADIOTELESCOPE FUNCTIONING AT 930 MHz AT THE BORDEAUX OBSERVATORY. **Bernyer, J.; Poumeyrol, F.; Rousseau, J. M. (Observatoire de Bordeaux).** Ann. Astrophys., 29: 307-9(May-June 1966).

The design, construction, and applications of a new radio telescope commissioned at the Bordeaux Observatory are described. A block diagram of the receiver is illustrated. Characteristics of the preamplifier, amplifier, detector, circuit integrator, local oscillator, and registration equipment are outlined. Radiation diagrams were determined experimentally from observations on the sun, and some data obtained for the solar flares on October 4, 1965, and January 17, 1966, are illustrated. The data obtained at 930 Mcps at Bordeaux are compared with those obtained at the Nancay Observatory at 169 and 408 Mcps. The October 4, 1965, event was not recorded at 169 Mcps. It was noted that variations of the order of a few minutes were more frequent at 930 Mcps than at 408 Mcps. These variations appeared to be characteristic of flares observed in the decimetric wavelength range. (BBB)

41724 THE SOLAR CORONA DURING THE TOTAL ECLIPSE OF NOVEMBER 12, 1966 AND APPARENT POSITION OF THE MAGNETIC POLES OF THE SUN. **Falciani, Roberto; Righini, Alberto; Rigutti, Mario.** Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur., 42: 41-5(Jan. 1967). (In Italian).

A description of the instrument used to photograph the solar corona during the eclipse of November 12, 1966, is given. The determination of the position of the radii passing through the magnetic poles is performed. (auth)

41725 SPECTRA OF THE SOLAR CORONA DURING THE TOTAL ECLIPSE OF NOVEMBER 12, 1966. **Falciani, Roberto; Righini, Alberto; Rigutti, Mario.** Atti. Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur., 42: 209-11(Feb. 1967). (In Italian).

A description of the instrument used to obtain spectra of the solar corona during the eclipse of November 12, 1966, is given. The spectra were obtained through a Polaroid. Emissions in the H and K lines of Ca II of the F component were observed. (auth)

41726 ELECTRICITY, GRAVITY, AND COSMOLOGY. Gamow, G. (Univ. of Colorado, Boulder). Phys. Rev. Lett., 19: 759-61(Sept. 25, 1967).

The ratio of electrostatic and gravitational forces between two protons, $e^2/\gamma m_p 2 = 1.24 \times 10^{36}$, proposed by Dirac is considered. The proposition that while γ remains constant, e^2 increases in direct proportion to the age of the Universe is discussed in some detail. (W.D.M.)

41727 PARKES HYDROGEN-LINE SURVEY OF THE MILKY WAY. I. THE GALACTIC CENTRE. Kerr, F. J. (CSIRO, Chippendale, Australia); Vallak, Reet. Aust. J. Phys., Astrophys. Suppl. No. 3, 1-27(Mar. 1967).

This paper is the first of a series dealing with a large-scale survey of the Milky Way with the Parkes 210-ft telescope. It covers observations along the galactic equator from $l^{II} = 355°$ to $l^{II} = 5°$ and over an area of 4 sq deg around the center, with line profiles taken at points 6′ arc apart. The major emission and absorption features are discussed, with particular reference to Sagittarius A absorption, the nuclear disk, and the 3 kpc arm. (auth)

41728 NINE MILLION WAVELENGTH BASELINE INTERFEROMETER MEASUREMENTS OF 3C 273B. Gubbay, J. S.; Robertson, D. S. (Weapons Research Establishment, Salisbury, Australia). Nature (London), 215: 1157-8(Sept. 9, 1967).

Observations on the angular dimensions of the variable radio source 3C 273B, using effective baselines of up to 2 million wavelengths, reduced the upper limit on its angular size to 0.025 sec arc at a wavelength of 6 cm. Observations using a trans-Canadian baseline indicated that the source is unresolved at an operating frequency of 600 Mc and an effective baseline of 6 million wavelengths. The authors attempted to operate two of the NASA Deep Space Stations in Australia as an intensity interferometer of exceptionally high resolution, giving a baseline of more than 9 million wavelengths at an operating frequency of 2,295 Mc. Signals from 3C 273B were recorded in digital form at the two stations, using analog-to-digital converters controlled by SDS 920 computers. The sampling rate (1 kc/sec) was controlled by rubidium frequency standards at both stations. Results are presented and discussed. The results were not inconsistent with a totally unresolved source, that is, a source with angular dimension <0.008 sec arc. (UK)

41729 FLUCTUATIONS IN THE PRIMORDIAL FIREBALL. Silk, J. (Harvard Coll. Observatory, Cambridge, Mass.). Nature (London), 215: 1155-6(Sept. 9, 1967).

One of the great difficulties of realistic cosmological models is the inadequacy of Einstein's gravitational theory to explain the process of galaxy formation. A way of evading this problem has been to postulate an initial spectrum of primordial fluctuations. Interpretation of the recently discovered 3°K microwave background as being of cosmological origin implies that fluctuations may not condense out of the expanding universe until an epoch when matter and radiation have decoupled, at a temperature of the order of 4,000°K. This communication discusses the question as to whether fluctuations in the primordial fireball would survive to an epoch when galaxy formation was possible. It has been pointed out that fluctuations ranging in size from a photon mean free path up to the event horizon will be damped out by neutrino viscosity during the 10^{10} to 10^{11}°K epochs. At 10^{10}°K, however, the event horizon contains only 10^{-4}M, in a small amplitude fluctuation. A purpose of this communication is to demonstrate that a considerably more significant upper limit may be obtained by considering the effects of radiative diffusion on opaque fluctuations at subsequent epochs. (UK)

41730 FRIEDMANN COSMOLOGICAL MODEL WITH BOTH RADIATION AND MATTER. Jacobs, K. C. (California Inst. of Tech., Pasadena). Nature (London), 215: 1156-7(Sept. 9, 1967).

The discovery and investigation of cosmic black-body radiation have led to fairly reliable calculations on such evolutionary phenomena as the temperature–density history of the Universe, primordial element formation, expansion anisotropy, and galaxy formation. The isotropy of this radiation supports the current practice of idealising the Universe as spatially homogeneous and isotropic, and as filled with pressureless matter and isotropic radiation. In this standard model of the Universe radiation dominates for about the first 2,000 years of evolution, and matter predominates thereafter. The present communication presents a new analytical solution to the cosmological model containing both radiation and matter. The assumptions of this model are (1) Friedmann spatial homogeneity and isotropy, (2) a stress–energy with both pressureless matter and isotropic radiation, (3) independent adiabatic expansion of the radiation and matter with negligible interchange of energy. If the Universe is spatially homogeneous, isotropic and Euclidean this model should be an excellent approximation from about 20 sec after creation, when the thermal electron energies become nonrelativistic, until the present time. It is argued that McIntosh's model (Nature, 215: 36(1967)) is physically unsatisfactory. (UK)

41731 CRITIQUE OF THE "CLARK" EFFECT. Wagoner, R. V. (California Inst. of Tech., Pasadena. Inst. of Theoretical Astronomy, Cambridge, Eng.). Nature (London), 215: 943-4 (Aug. 26, 1967).

Direct measurement of magnetic field strengths within the Galaxy would be of great importance for understanding its structure and evolution, and Clark (Nature, 197: 474 (1963)) proposed a method based on the effect of a magnetic field on the anomalous dispersion of 21-cm radiation passing through neutral hydrogen. It is stated that Clark's calculations contain a fundamental error, in neglecting induced scattering from an excited state. (UK)

41732 MECHANISM FOR ANOMALOUS OH EMISSION FROM H II REGIONS. Hughes, V. A. (Queen's Univ., Kingston, Ont.). Nature (London), 215: 942-3(Aug. 26, 1967).

Several suggestions have been made to explain the formation of OH in the galaxy. It is usually assumed that OH is produced in the presence of interstellar particles by sputtering or by a process of chemical exchange on the particles. Laboratory studies have led to a possible mechanism involving the formation of OH in an electronically excited state as a two-body process involving atomic oxygen and hydrogen, with the emission of radiation in the 3064 Å band. Since this reaction could well be taking place in cooler parts surrounding individual H^{II} regions, it is of interest to assess the possibility that it is also the cause of anomalous OH emission. A realistic region for OH formation is in the pressure wave immediately ahead of a D-type ionisation front, and observed Doppler shifts are consistent with this hypothesis. Detailed calculations show that rates of formation under the proposed mechanism are too small for the intensity to be produced entirely in the pressure wave, but that the pressure wave is a region of amplification of the radiation from a source situated behind it. Observations that the source can have dimensions as small as 10^{-4} pc support this suggestion. The suggested mechanism has the attraction that it may be amenable to observation, particularly from space vehicles. (UK)

41733 RADIO SOURCE W49 AND ANOMALOUS OH EMISSION. Hughes, V. A.; Butler, R. (Queen's Univ., Kingston, Ont.). Nature (London), 215: 941-2(Aug. 26, 1967).

This source is situated in the galactic plane in a direction of high optical obscuration, so that information can only be obtained at radio wavelengths. The source is an H II region. Some new high resolution observations are reported, using the new 150-ft radio telescope at the Algonquin Radio Observatory at wavelength of 2.85 cm, supplemented by observations at 9.45 cm. The indication that OH emission is associated with areas of H II regions of comparatively high density is not inconsistent with previous theories, but the new results, when considered in conjunction with laboratory measurements, suggest that the anomalous OH emission observed from the source might be explained as a result of the formation of OH in an electronically excited state by a two-body process involving atomic oxygen and hydrogen. Such a reaction could be a competing mechanism in dense regions. (UK)

41734 RED-SHIFT MAGNITUDE RELATION FOR QUASI-STELLAR OBJECTS. Longair, M. S.; Scheuer, P. A. G. (Cambridge Univ., Eng.). Nature (London), 215: 919-22(Aug. 26, 1967).

A red-shift magnitude correlation for quasi-stellar objects exists, but it does not imply a red-shift distance relation. If the red-shifts of quasi-stellar objects are cosmological their mean optical magnitude has changed with epoch. (UK)

41735 THE OCCURRENCE OF SINGULARITIES IN COSMOLOGY. III. CAUSALITY AND SINGULARITIES. Hawking, S. W. (Cambridge Univ., Eng.). Proc. Roy. Soc. (London), Ser. A, 300: 187-201(Aug. 30, 1967).

The questions about singularities that remain to be answered are discussed. It is shown, without any assumption about causality, that there are fully general solutions which evolve from a non-singular state to an inevitable singularity. An observationally testable condition is given which would imply the existence of a singularity if a reasonable assumption about causality were made. This condition would be satisfied in an approximately spherical collapsing star and so would enable proof of the occurrence of a singularity in such circumstances without assuming that space-time admits a Cauchy surface. If the assumption about causality held, the singularity could not be of the Misner type but would presumably involve infinite curvature. This would probably indicate that the Einstein theory broke down, but only in very strong fields. (auth) (UK)

41736 RELATIVISTIC THEORY OF SUPERMASSIVE STARS. Hameen-Anitila, K. A. (Univ. of Oulu, Finland). Ann. Acad. Sci. Fenn., Ser. A VI., No. 225, 1-15(1966).

Relativistic theory of supermassive gas spheres is represented in mathematically ameliorated form. The gas pressure is shown to be negligible not only in the interiors but on surface layers as well. The main source of opacity in supermassive gas spheres is found to be throughout the electron scattering. The time scale of these objects is estimated and the minimal value of their relativity parameter is derived. (auth)

41737 PHOTOMETRY IN SIX COLORS, THE STARS OF O. C. WILSON. Rousseau, Jeanine (Univ., Lyon). Compt. Rend., Ser. A and B, 264: 1526-9(May 29, 1967). (In French).

The hypotheses proposed by O. C. Wilson, Pagel, Cayrel, and Jugaku for the interpretation of the O. C. Wilson stars are examined, beginning with observations in six colors (Lick system). (tr-auth)

41738 POSSIBLE RELATIONSHIP BETWEEN RADIO FLUX DENSITY AND RED-SHIFT FOR QUASARS. Horton, P. W.; Daintree, E. J. (Univ. of Manchester, Eng.). Nature (London), 215: 917-18(Aug. 26, 1967).

Demonstration of a relationship between the flux densities and red shifts of quasars suggests that the red shifts give an indication of quasar distances. (UK)

41739 SPALLATION OF NEON, ARGON, KRYPTON, AND XENON IN AN IRON METEORITE. Munk, Miner N. (Univ. of California, Berkeley). Earth Planet. Sci. Lett., 2: 301-9(July 1967).

The abundances of the 21 stable isotopes of neon, argon, krypton, and xenon were measured in the Costilla Peak iron meteorite. A pronounced spallation component was observed in all four of the gases; and that the neon and argon results agree with previous iron meteorite measurements. Integration of a recent Rudstam formula over the Arnold, Honda, and Lal cosmic-ray spectra accurately predicts the isotopic composition of the observed spallation component in all cases except, possibly, neon. Calculated production rates for ^{21}Ne and ^{38}Ar give cosmic-ray exposure ages of 560 m.y. and 500 m.y., respectively, for a sample depth of 100 g/cm^2. We obtain large variations in the exposure ages based on krypton and xenon, which might be explained by lack of knowledge about target element abundances. The small and questionable amount of ^{129}Xe in addition to the trapped and spallation components indicates a longer ^{129}I–^{129}Xe formation interval for Costilla Peak than for the Chondrites. (auth)

41740 PARTICLE-INDUCED ELECTROMAGNETIC DE-EXCITATION OF NUCLEI IN STELLAR MATTER. Shaw, Peter B. (Pennsylvania State Univ., University Park); Clayton, Donald D. Phys. Rev., 160: 1193-1202(Aug. 25, 1967).

The rate for electromagnetic de-excitation of excited nuclei by inelastic scattering with electrons and ions in stellar matter is calculated as a function of temperature, density, transition energy, and multipole type. The results indicate that for temperatures in the range 10^9 °K < T < 10^{10} °K and densities in the range 10^9 g/cm^3 < ρ < 10^{12} g/cm^3, particle-induced electromagnetic de-excitations compete favorably with spontaneous radiative transitions. As an example, a ^{12}C nucleus, put in the 7.65-MeV 0$^+$ excited state and embedded in an electron-helium plasma with a density of 10^{11} g/cm^3, will be de-excited by electromagnetic interaction with the plasma 40 times faster at T = 10^9 °K and 500 times faster at T = 10^{10} °K than its natural radiative rate. At the lower temperature the de-excitation is dominated by the electrons, and at the higher temperature by the helium ions. The conditions for the applicability of the present work to modern astrophysical problems are discussed. (auth)

41741 STATISTICAL TIME SYMMETRY AND TWO-TIME BOUNDARY CONDITIONS IN PHYSICS AND COSMOLOGY. Cocke, W. J. (Goddard Space Flight Center, New York). Phys. Rev., 160: 1165-70(Aug. 25, 1967).

The hypothesis of complete time symmetry in oscillating cosmologies in which there exist locally irreversible processes is examined. A time-symmetric formalism for purely statistical processes is developed, and all aspects of quantum and statistical mechanics are shown to be time-symmetric within this framework. It is concluded from analysis of a simple example that in a completely time-symmetric oscillating cosmology, statistical processes which produce entropy in the expanding phase will reverse themselves in the contracting phase, although microscopic reversal of motion need not occur. The analysis provides a self-consistent formalism for general problems involving the coexistence of different entropic directions of time in the observable universe. Boltzmann's H theorem is discussed in this framework. (auth)

41742 QUASI-STELLAR RADIO SOURCES. Longair, M. S. (Cavendish Lab., Cambridge, Eng.). Contemp. Phys., 8: 357-72(July 1967).

The radio and optical characteristics of quasi-stellar radio sources are described and contrasted with those of radio galaxies. It is shown how the synchrotron hypothesis of the radio emission from those objects can explain many of the features of their radio spectra. Once a consistent model for the evolution of quasi-stellar radio sources and radio galaxies is sought many difficulties are encountered, particularly during the early stages when the radiation density is very great. However, the present observational data allow several important conclusions to be drawn about the evolution of quasi-stellar radio sources and radio galaxies in general. (auth)

41743 RADIO OBSERVATIONS OF INTERSTELLAR HYDROXYL RADICALS. Barrett, Alan H. (Massachusetts Inst. of Tech., Cambridge). Science, 157: 881-9(Aug. 22, 1967).

The discovery of the rf lines of OH gave the first positive evidence of the existence of OH in the interstellar medium. In the 3½ years since, many observations have revealed totally unexpected anomalies in the radio-spectral properties of interstellar OH. As a result, no reliable astrophysical information has been derived from the OH observations, but a large body of information awaits analysis. (W.D.M.)

41744 SOLAR MODELS. Dicke, R. H. (Princeton Univ., N. J.). Science, 157: 960(Aug. 25, 1967).

Various aspects of previously reported work on instability in a solar model with a rapidly rotating core are discussed. (J.H.M.)

41745 INTERSTELLAR GAS DYNAMICS. Second Revised Edition. Kaplan, S. A.; Kahn, F. D. (eds.). International Series of Monographs in Natural Philosophy. Vol. 3. Oxford, Pergamon Press, 1966. 138p. 40s.

The subject is treated under the following main headings: distribution and motion of interstellar gas; physical state of the interstellar gas; discontinuities in the motion of the interstellar gas; and equations of motion of the interstellar gas. (UK)

41746 GALAXIES, NUCLEI, AND QUASARS. Hoyle, F. London, Heinemann, 1966. 167p. 25s.

This book is based on lectures given during 1964 to university audiences. The treatment is intended to emphasise the very fluid state of modern astronomy and cosmology. Headings are as follows: galaxies; radio sources; x rays, T rays, and cosmic rays; steady-state cosmology; a radical departure from the steady-state concept; and outline of the history of matter. (UK)

41747 AN INVESTIGATION OF THE MAGNETIC AND RELATED STARS THROUGH PHOTOELECTRIC NARROW-BAND PHOTOMETRY. Cameron, Robert Curry. Washington, D. C., Georgetown Univ., 1966. 390p.

Thesis.

Three hundred peculiar A stars (Ap stars), exhibiting enhanced spectral lines of certain elements, and 100 metallic-line A stars (Am stars), exhibiting general enhancement of the metallic spectrum, were observed photoelectrically with the 16-inch reflector of the Kitt Peak National Observatory. The great majority of the 93 known magnetic stars and 66 suspected magnetic stars (displaying Zeeman splitting of the spectral lines) are of the Ap or Am types, and are necessarily sharp-lined for detection of the Zeeman effect. The principal program stars included, in addition to the magnetic stars, Ap and Am stars with relatively broad spectral lines and also others which have never been examined for the Zeeman effect. Additional normal comparison stars and stars with unusual characteristics were observed also. The total number of stars observed was 749. (TSS)

41748 OSNOVY KOSMICHESKOI ELEKTRODINAMIKI. (Principles of Cosmic Electrodynamics). Pikel'ner, S. B. Second Edition. Moscow, Izdatel'stvo Nauka, 1966. 408p.

The principles of cosmic electrodynamics are developed. The general properties of plasmas are outlined. The interaction of magnetic fields and moving conducting media is discussed. Waves in plasma are described, and plasma stability is considered. Some forms of the motion of continuous media are described. The equations representing the magnetohydrodynamics of the Galaxy, stars, and the Sun are given. (J.S.R.)

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Refer also to abstracts 42329, 42373, and 42720.

41749 (AD-644978) THE IONIZATION OF HYDROGEN AND OF HYDROGENIC POSITIVE IONS BY ELECTRON IMPACT. Re-

search Paper. Rudge, M. R. H.; Schwartz, S. B. (Douglas Aircraft Co., Inc., Huntington Beach, Calif. Advanced Research Lab.). Feb. 1966. 52p. (DARL–5). CFSTI.

Calculations of the ionization cross sections of hydrogen and of hydrogenic positive ions are described in which the initial state is either the ground or the excited 2s state. The first procedures used are the Born (ii) and Born-exchange approximations. These results were compared with other theoretical calculations and with experimental data. It was found that for the case of ionization of hydrogen from its ground state, none of the theoretical results is in good agreement with the experimental data. A certain defect of the theory is then corrected by adopting a third procedure for this case, in which an angle-dependent Coulomb potential is used in the description of the final state of the e–H ionization problem. It was then found that, despite the sounder theoretical footing of this latter calculation, no improved agreement with experimental data was obtained except in the near threshold region. Convenient formulas are presented which represent the best data for the ionization cross sections and the associated reaction rates for the case of an initial Maxwellian distribution of velocities. (auth)

41750 (AD–644979) THE IONIZATION OF COMPLEX IONS BY ELECTRON IMPACT. I. IONIZATION CROSS SECTIONS FOR Fe XV AND Fe XVI. Research Paper. Rudge, M. R. H.; Schwartz, S. B. (Douglas Aircraft Co., Inc., Huntington Beach, Calif. Advanced Research Lab.). Feb. 1966. 21p. (DARL–6). CFSTI.

The Born (ii) and Born-exchange approximations are applied to the calculation of ionization cross sections for the coronal ions Fe XV and Fe XVI by electron impact. Tables of ionization cross sections and reaction rates are presented. (auth) (TAB)

41751 (AD–646244) ELECTRON SCATTERING. Semiannual Technical Summary Report, September 30, 1966. Bederson, B.; Borowitz, S.; Spruch, L. (New York Univ., N. Y. Dept. of Physics). Sept. 30, 1966. Contract Nonr-285(60). 19p. CFSTI.

Experimental and theoretical atomic physics at New York University is described. The experimental work includes (1) total low energy e–O and e–O_2 cross sections; (2) tensor polarizabilities of metastable Hg; (3) threshold behavior of 4 doublet-P $^1/_2$, $^3/_2$ states of K by electron bombardment and state selection of K beam; (4) cold (150°K) microwave discharge atomic beam H source; (5) new e–molecule total cross section and tensor polarizability apparatus; (6) new e–metastable rare gases' total cross sections experiment; (7) Li beam Cs plasma interactions. The theoretical scattering work includes: (1) long range potentials and functions required in partial-wave effective range theory; (2) variational lower and upper bounds on phase shifts; (3) variational bounds on parameters using Feynman formulation of Q.M.; (4) comparison of variational bound formalisms; (5) conditions for existence of bound states; (6) bounds on matrix elements; (7) collective oscillations of atoms. (auth) (TAB)

41752 (BNL–11682) NUCLEAR-ATOMIC POLARIZATION EFFECTS. Church, E. L. (Frankford Arsenal, Philadelphia, Pa.); Weneser, J. (Brookhaven National Lab., Upton, N. Y.). Aug. 1967. 7p. (CONF-670812–5). Dep. CFSTI.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif.

To understand nuclear atomic polarization effects, the hyperfine interaction must be considered to second order, and this introduces a dependence on off-diagonal matrix elements as well as diagonal ones. A simple interaction was used to explore such effects. The total Hamiltonian contains the point-Coulomb interaction. The unperturbed part replaces the point-Coulomb interaction by a granular charge distribution. The multipole expansion of this perturbation outside the nucleus is shown. (M.H.R.)

41753 (CALT–532–12) EXCHANGE EXCITATION OF HELIUM AND THE HYDROGEN MOLECULE BY LOW ENERGY ELECTRONS. Cartwright, David Chapman (California Inst. of Tech., Pasadena). June 23, 1967. Contract AT(04-3)-532. 305p. Dep. CFSTI.

Thesis.

The theory of rearrangement collisions involving composite particles is reviewed and the "post," "prior" discrepancy discussed. Two recent improvements to the Born–Oppenheimer approximation, the Ochkur (O), and Ochkur–Rudge (OR) approximations are reviewed. These approximations are then used to calculate the total cross section for the electronic excitation, of molecular hydrogen by low energy electrons. Excitations from the ground ($X^1\Sigma_g^+$) state to the first ($b^3\Sigma_u^+$) and second ($a^3\Sigma_g^+$) triplet states are treated. All nuclear motions are taken into account. It is found that the first triplet cross section is sensitive to the choice of the ground state wave function whereas the second is not. The former is also sensitive to the quality of excited state wave function used. The results using the (O) approximation are significantly larger than those of the (OR) approximation, and the maximum cross section occurs at a somewhat lower energy. Use of the separated atom approximation produces results significantly lower than those obtained by including all the multicenter terms in the scattering amplitude. The calculations are carried out using the zeta function expansion method and are quite lengthy. The sum of the first and second (OR) triplet cross sections agrees well with a recent approximate experimental determination of the cross section for electron impact dissociation of H_2 into 2H. These approximations are also used to calculate the total cross sections for excitation of helium from the ground to the 2^3S and 2^3P states. These cross sections are sensitive to the ground and excited state wave functions used. The (OR) results agree well with the available experimental data for these excitations. The differential cross sections for these excitations are also calculated. Since there is no experimental data for the H_2 processes or for the 2^3P excitation in He, the quality of these calculations cannot be evaluated. The calculated angular distributions for the 2^3S excitation in He agree well with one set of experimental data but disagree with the other. The (OR) approximation is found to give quite good results for total cross sections but its value in predicting angular distributions cannot be evaluated until more experimental data are available. (auth)

41754 (IN–1115) TRANSVERSE COLLECTIVE ATOMIC VIBRATIONS IN LIQUID LEAD. Randolph, P. D.; Myers, W. R. (Idaho Nuclear Corp., Idaho Falls). Aug. 1967. Contract AT-(10-1)-1230. 10p. Dep. CFSTI.

Slow neutron inelastic scattering measurements have been made of the dispersion relations $\omega(\kappa)$ for the collective vibrational modes in liquid lead at 350°C, for small scattering angles (3 to 18°) at incident energies of 30 and 50 MeV. The collective excitations appear as abrupt slope changes or shoulders in the energy spectra of inelastically scattered neutrons and span momentum transfers $\hbar\kappa$ in the range of $0.3 \leq \omega \leq 1.5$ Å^{-1} and frequencies $1.5 \leq \omega \leq 15 \times 10^{12}$ rad/sec. Usually two such excitations occur at a given scattering angle and sometimes three. The data show that three modes of collective vibrations exist similar to longitudinal and transverse acoustic vibrations in the solid, but the branches cannot be clearly distinguished over the whole κ range. A lower limit for the transverse relaxation time is estimated and it is concluded that for times of the order of 10^{-12} sec the groups of atoms supporting the modes are not isotropic. (auth)

41755 (ORNL–AMPIC–6) BIBLIOGRAPHY OF ATOMIC AND MOLECULAR PROCESSES FOR JULY–DECEMBER 1965. (Oak Ridge National Lab., Tenn.). Sept. 1967. 257p. Dep. CFSTI.

An annotated bibliography is presented which contains references of interest to atomic and molecular processes research. Bibliographical sources consisted of seventy-eight scientific journals and five abstract journals. The references are classified into fourteen major categories with appropriate subcategories. Each entry in the respective category is entered alphabetically and includes the reactants or the atomic and molecular system of interest. (auth)

41756 (UCRL–17342) EXCHANGE COLLISIONS BETWEEN THE IONIC GROUND STATE AND THE NEUTRAL METASTABLE STATE OF ATOMS FORMED AND ALIGNED BY ELECTRON IMPACT. Hadeishi, Tetsuo; Liu, Chung-heng (California Univ., Berkeley. Lawrence Radiation Lab.). July 5, 1967. Contract W-7405-eng-48. 7p. (CONF-670702–6). Dep. CFSTI.

From 5th International Conference on Physics of Electronic and Atomic Collisions, Leningrad, USSR.

The radio-frequency paramagnetic resonance method was used to observe the exchange collisions between the Xe ionic ground state having a $^2P_{\frac{1}{2}}$ configuration and the neutral metastable state having a $^3P_2$ configuration. The ionic ground-state and the metastable-state atoms are both formed and aligned by unidirectional low-energy, high flux electron beam impact. The magnetic resonance of the ionic ground-state atoms was observed by monitoring changes in the transparency of the resonance radiation to the metastable state. By means of a simple apparatus, it was found that: (1) it is possible to observe alignment of the ionic ground state and, (2) it is possible to align the nucleus in the $^1S_0$ ground state. (M.H.R.)

41757 (UCRL–Trans–10124) ABSOLUTE MEASUREMENT OF BREMSSTRAHLUNG SPECTRA EMITTED FROM THICK TARGETS IN THE 500 keV ENERGY REGION. Jaschik, J. Translated by P. Unger for Univ. of California Lawrence Radiation Lab., Livermore, from Z. Angew. Phys., 22: 510–16(1967). 23p. Dep. CFSTI. JCL $2.60 fs, $0.92 mf.

A scintillation spectrometer is used to measure the absolute spectral and spatial distributions of the bremsstrahlung emitted from thick targets of various atomic numbers in the 0.5 MeV

energy region. The results have been corrected for counting losses, background, and photon energy losses, including those in the target. Integration of the results over the whole solid space allows a comparison between the experimental distribution with Kramer's formula. A systematic relationship is found between the mean total radiation loss per electron divided by the atomic number Z, and Z'. The determined bremsstrahlung efficiencies are compared with the calculations of Kirkpatrick and Jaeger's empirical formula. (auth)

41758 FAST CHARGED PARTICLE IN EXTERNAL ELECTROMAGNETIC FIELD. Kalashnikov, N. P.; Ryazanov, M. I. pp 162-6 of Vzaimodeistvie Izluchenlya s Veshchestvom. Alekseev, A. I. (ed.). Moscow, Atomizdat, 1966. (In Russian).

An approximate equation was obtained for the wave function of a fast particle moving in an arbitrary external field in the case in which the disparity $|\partial\psi(x)/\partial x_\nu| \gg |\psi(x)A_\nu(x)|$ is fulfilled.

41759 ZEEMAN-EFFECT ANALYSIS OF THE SPECTRUM OF NEUTRAL GADOLINIUM (Gd I). Pinnington, Eric H. (Univ. of Alberta, Edmonton). J. Opt. Soc. Amer., 57: 1252-9 (Oct. 1967).

199 Zeeman patterns are presented for Gd I, from which g values are calculated for 118 levels. A discussion is given of the terms and electron configurations to which previously unassigned even levels may belong; new assignments are given for 15 even levels belonging to four terms (^{1}P, ^{3}F, ^{3}D, ^{1}D) of the configuration $4f^7(^8S_{7/2})5d6s6p$. Russell's prediction that the next even configuration, $4f^7(^8S_{7/2})5d^26p$, begins at ~25,000 cm^{-1} is confirmed. The observed g values in general lie within ±5% of the L–S coupling values, but marked deviations occur for some levels, indicating that energy-level mixing is present. (auth)

41760 ZEEMAN-EFFECT INVESTIGATIONS IN SINGLY IONIZED GADOLINIUM (Gd II). Desmarais, D.; Pinnington, Eric H. (Univ. of Alberta, Edmonton). J. Opt. Soc. Amer., 57: 1245-51(Oct. 1967).

Results are presented for 120 Zeeman patterns in Gd II, from which g values for 67 levels are calculated. The problem of determining the magnetic field strength to a sufficient accuracy is discussed. The phenomenon of mixing of polarizations is attributed to scattering in the light source. The predictions of Smith and Wybourne are found to agree within experimental error for 18% of these levels and within 2% for 77% of them. An attempt is made to reassign the percentage composition of the levels y^8P, z^8P, z^8F and $z^{10}D$, for which the observed g values differ markedly from those predicted. Finally the composition of the even level, $4_{9/2}$, is discussed. (auth)

41761 ON ATOMIC POLARIZABILITIES, COUPLED AND UNCOUPLED APPROXIMATION IN THE CASE OF SEVERAL OPEN SHELLS OF ELECTRONIC SYSTEMS. Malinowski, S. (Univ. of Lodz, Poland). Acta Phys. Pol., 32: 53-9(July 1967).

General expressions are given for the atomic polarizabilities $\alpha_2 L$ in the case of several open shells of electronic systems, and equations for unknown perturbed wave functions $u_i^{\alpha(L)}$ in the case of coupled and uncoupled approximation. (auth)

41762 ONE WAY TO DECIDE THE COMPTON SCATTERING ANGLE FROM ITS CUMULATIVE PROBABILITY IN THE MONTE CARLO CALCULATION. Yamakoshi, Hisao; Nakata, Masaya (Ship Research Inst., Tokyo). Senpaku Gijutsu Kenkyujo, 2: 311-6(Nov. 1965). (In Japanese).

A way to decide the Compton scattering angle from a random number given as its cumulative probability is presented. This is useful for tracing rather high-energy γ rays in the Monte Carlo calculation method. As an example, four tables necessary for the γ-ray energy range from 5 to 10 MeV are shown. The example gives the scattering angle with accuracy less than one degree through one lookup step and at most, five multiplying and two dividing steps. (NSA of Japan)

41763 ELECTRIC DIPOLE MOMENT OF THE CESIUM ATOM. A NEW UPPER LIMIT TO THE ELECTRIC DIPOLE OMENT OF THE FREE ELECTRON. Stein, T. S.; Carrico, J. P.; Lipworth, E.; Weisskopf, M. C. (Brandeis Univ., Waltham, Mass.). Phys. Rev. Lett., 19: 741-3(Sept. 25, 1967).

The results of experiments in which the motional magnetic field $\vec{v} \times \vec{E}$ is measured directly on the Zeeman transitions $(F, \underline{m}_e = -I \pm \frac{1}{2}) \rightleftharpoons (F, -I - \frac{1}{2})$ of several of the alkali atoms are reported. Experiments consist of studying the signal linear in $\vec{E}$ as a function of the current through the vertical field coils and determining the point of zero signal (intercept) in each element. The intercepts of several alkalis are compared. (M.H.R.)

41764 ELECTRON AFFINITY OF HELIUM VIA LASER PHOTODETACHMENT OF ITS NEGATIVE ION. Brehm, B.; Gusinow, M. A.; Hall, J. L. (National Bureau of Standards, Boulder, Colo. Univ. of Colorado, Boulder). Contract DA-31-124-ARO-D-139. Phys. Rev. Lett., 19: 737-41(Sept. 25, 1967).

The direct measurement of the electron affinity of helium (2^3S), by the technique of energy analysis of electrons photodetached from a beam of negative helium ions by monochromatic (laser) light is reported. The energy of the electrons photodetached from a beam of negative helium ions passing through the high-power intracavity electromagnetic field of a continuous-duty argon-ion laser was analyzed. The apparatus consists of five parts: ion source, Wien (mass) filter, laser light source, electron energy analyzer, and pulse-counting and control electronics. Positive ions of helium and deuterium (and sometimes hydrogen) are extracted from a hot-cathode arc-discharge source. The experimental results are tabulated. (M.H.R.)

41765 SYSTEMATIC IMPROVEMENT OF THE SMALL-ANGLE APPROXIMATION IN THE THEORY OF MULTIPLE SCATTERING. Hemmer, P. C.; Farquhar, I. E. (London Univ.). Ark. Fys. Seminar Trondheim, No. 7, (1967).

In the theory of the elastic multiple scattering of a charged particle in a plane it is usually assumed that the elementary scattering law is Gaussian and that all angles involved are small. While the first assumption is retained here, a power series expansion is used to effect a systematic improvement in the second, the small-angle approximation corresponding to the zero order approximation to this expansion. A method of integration in function space is used to determine the joint probability of lateral and angular displacements of the scattered particle, in principle to any order in the expansion parameter; this computation is carried out explicitly to first order in the parameter. This joint probability is employed to obtain first-order corrections to previous results concerning first the lateral displacement y(L/2) midway between two selected points distant L apart on the track of the scattered particle and secondly the mean squared curvature $\overline{C^2}$ of the track; in the former instance is obtained $\overline{y^2}(L/2) = (L^3/48\lambda)\{1 + (23L/96\lambda)\}$, where λ is the scattering parameter, and in the latter $\overline{C^2} = (4/3\lambda L)\{1 - (25L/96\lambda)\}$. For tracks both in two and in three dimensions, first-order corrections are determined also to results of the small-angle approximation for the actual path length of particles passing through a foil, both when the particles emerge normally to the foil and when they emerge in any direction. The results indicate that the discrepancy reported between theoretical predictions and some experimental measurements of multiple scattering is not attributed to the use of the small angle approximation in the theoretical description. (auth) (NORW)

41766 DETECTION OF ELECTRONS OF 2 TO 40 keV WITH SCINTILLATION CRYSTALS. Faber, K. (Technische Hochschule, Munich). Z. Angew. Phys., 23: 240-3(1967). (In German).

The scintillation response L and the detection efficiency N for the inorganic crystals NaI(Tl), KI(Tl), CsI(Tl) as well as for anthracene and a plastic scintillator were determined by bombardment with electrons in the energy range from 2 to 40 keV. As a result L was found to be a nonproportional function of energy E over the whole energy range. Above 6 keV there was linearity between L and E. Below 6 keV the curve deviates from the straight line and passes through the origin. Above 20 keV N reaches a constant value, which depends on the scintillator only. Below 20 keV the pulse-height distribution is highly distorted as "after pulses" of the crystal become more important. Below 10 keV the presence of the single-electron line in the photomultiplier and the interruption of electron cascades in the dynode system lead to a further deformation. Corrections for these effects were made. (auth)

41767 MEASUREMENT OF ATOMIC-STOPPING CROSS SECTIONS AT LOW ENERGIES. White, W.; Mueller, R. M. (Nuclear-Chicago Corp., Des Plaines, Ill.). J. Appl. Phys., 38: 3660-2(Aug. 1967).

A method for the measurement of the electronic-stopping cross section S_e for atomic particles in solids is presented and demonstrated by measurement of S_e for ^{1}H and ^{4}He in aluminum in the energy range 20 to 140 keV. (auth)

41768 ION CYCLOTRON RESONANCE LINE BROADENING AT HIGH E/P. Wobschall, Darold C.; Fluegge, Robert A.; Graham, John R. Jr. (Cornell Aeronautical Lab., Inc., Buffalo). J. Appl. Phys., 38: 3761-7(Aug. 1967).

Observations were made of ion cyclotron resonance absorption linewidths and shapes at values of E/P up to 400 V/cm·torr. Three methods of heating the ions are compared. If the detector rf electric field is used to heat the ions, the line shapes are distorted and not well suited for simple interpretation. With the dc heating method, the line shapes are close to Lorentzian and the collision cross section as a function of E/P can be determined from the increase in linewidth as a function of pressure. For He^+

in He at E/P = 100 V/cm·torr, the cross section is 30 Å², in fair agreement with previous studies. By heating with a separate oscillator fixed at the cyclotron frequency, similar line broadening is observed, but a dip appears at the center of the absorption line. This dip is attributed to a nonlinear dependence of collision frequency on electric field, and is enhanced by the strong dependence of the ion concentration on collision frequency under steady-state diffusion conditions. (auth)

41769 APPROXIMATE METHODS FOR TREATING RADIATIVE TRANSPORT IN A NON-GREY GAS WITH PLANE PARALLEL GEOMETRY. Sampson, Douglas H. (Pennsylvania State Univ., University Park). J. Quant. Spectrosc. Radiative Transfer, 7: 741-9(Sept.-Oct. 1967).

An approximate method for handling the frequency dependence of radiative transport is clarified and it is shown that under most conditions the additional use of the Eddington approximation should not appreciably reduce the accuracy in computed values for the flux and its divergence. Some slight modifications of the method, which should lead to improvement in results, are discussed. (auth) (UK)

41770 PROPERTIES OF THE ENTROPY PRODUCTION DUE TO RADIATIVE TRANSFER. Kroell, W. (Ruhr-Univ., Bochum, Ger.). J. Quant. Spectrosc. Radiative Transfer, 7: 715-23(Sept.-Oct. 1967).

The entropy production due to emission and absorption of radiation has been repeatedly considered in investigations of the irreversibility of radiative transfer. These investigations were primarily concerned with the sign of the entropy production. The general form of the entropy production is here analyzed and the sign of its time derivative discussed. Starting from basic statistical relations, it is shown that the entropy production due to emission, absorption and scattering of radiation is a form bilinear in generalized "thermodynamic fluxes" and "forces." This form exhibits its positive semi-definite character. It further enables the establishment of an evolution criterion by proving that a well defined part of the time change of the entropy production is negative semi-definite. The formalism and the results derived are extensions of fundamental relations of the classical theory of irreversible thermodynamics for transport processes in matter. (auth)

41771 ELECTRON PARAMAGNETIC RESONANCE (A REVIEW). Lancaster, G. (Univ. of Keele, Eng.). J. Mater. Sci., 2: 489-95(Sept. 1967).

The basic principles of the electron paramagnetic resonance technique are discussed, together with some results in certain fields which illustrate its range, applications, and potentialities. (auth) (UK)

41772 ENERGY ANALYSIS OF MEDIUM HIGH FREQUENCY ELECTRIC FIELD PULSED ELECTRON BEAMS. Korsch, D.; Schief, R. (Univ., Tuebingen, Ger.). Z. Angew. Phys., 23: 236-40(1967). (In German).

Short electron bursts are generated by sweeping a continuous electron beam over an aperture by means of a high-frequency electric field between a set of parallel plates. The energy distribution of the electrons is changed by this procedure. Measurements of the energy spread were made up to a deflection frequency of 900 MHz, the amplitude of the deflection voltage was 7 V. The initial "monochromatic" energy distribution split up into two lines of different energy. At an acceleration voltage of 23 kV and a deflection frequency of 900 MHz the energy spread of the two lines was 17 eV. A simplified assumption concerning the stray field was made and the energy spread was calculated. These theoretical results were in good agreement with the experimental data. (auth)

41773 STOPPING OF SWIFT PROTONS EVALUATED FROM STATISTICAL ATOMIC MODEL. Bonderup, Ejvind. Kgl. Dan. Vidensk. Selsk., Mat.-Fys. Medd., 35: No. 17, 1-19(1967).

Calculations of electronic stopping for heavy particles with low charge number are performed down to quite low energies, e.g., for protons down to ~100 keV. The treatment is a refinement of a procedure suggested by Lindhard and Scharff. This procedure makes extensive use of statistical models of the atom. Stopping as a function of energy is determined by the I value of the target material and the energy dependent "shell correction." As discussed, the shortcomings of the present statistical treatment should show up mainly in the I values. In fact, the shell corrections obtained appear to be comparatively accurate, especially in view of the fact that previous estimates have been made by fitting parameters in semi-empirical formulas. There is also a discussion of the possibility of determining I values from theoretical shell correction curves and experimental stopping powers at very low energies. (auth) (DENM)

41774 K-MESIC X-RAYS. Wilkinson, D. H. (Oxford Univ.). Comments Nucl. Particle Phys., 1: 112-15(May 1967).

A series of experiments at Berkeley on K-mesic x rays from Li, Be, B, and C are discussed, and the implications of the experiments on the study of nuclear surfaces are reviewed. (W.D.M.)

41775 CORRELATION OF FINAL CHARGE STATES OF PARTICLES IN DISCRETE ENERGY LOSSES IN ATOMIC COLLISIONS. Afrosimov, V. V.; Gordeev, Yu. S.; Polyanskii, A. M.; Shergin, A. P. (Ioffe Inst. of Physics and Tech., Leningrad). JETP Lett. (USSR) (Engl. Transl.), 6: 3-5(July 1, 1967).

Translated from Zh. Eksper. Teor. Fiz., Pis'ma Redakt., 6: 461-464(July 1, 1967).

The correlation of the final charge states was investigated for the processes $Ar^+ + Ar \rightarrow Ar^{m+} + Ar^{n+} + (m + n - 1)e$ (denoted 1, 0, m, n for short) under the condition that all three lines are simultaneously excited (energy of incoming particles $T_0 = 50$ keV, their laboratory scattering angle $\nu = 7°30'$). A coincidence method was used to determine the relative probabilities of the elementary processes 1, 0, m, n upon excitation of each of the lines. Inasmuch as the approach distance was fixed, all collisions corresponded to one and the same pattern of electron term crossing. In the analysis of the experimental data, the standard methods of correlation theory were used. (M.H.R.)

41776 SELF-ENERGY OF PARTICLES IN GENERAL RELATIVITY THEORY. Asanov, R. A.; Markov, M. A. (Joint Inst. for Nuclear Research, Dubna, USSR). JETP Lett. (USSR) (Engl. Transl.), 5: 341-2(June 1, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 5: 417-18(June 1, 1967).

The question is considered of how does the finite value of the charged-particle mass change if besides the electromagnetic and gravitational field, a possible action of other fields is allowed. (W.D.M.)

41777 EXISTENCE AND PROPERTIES OF THE TRIATOMIC MOLECULAR JETS OF DEUTERIUM. Devienne, F.-Marcel (Laboratoire Mediterrannen de Recherches Thermodynamiques, Nice). Compt. Rend., Ser. A and B, 264: 1400-3(May 17, 1967). (In French).

By charge exchange of D_1^+, D_2^+, and D_3^+ ion beams extracted from a hf source, molecular jets having different properties are obtained. In particular, the variation of the gain of a zinc sulfide photoscintillator shows the existence of D_3^* molecules in the molecular jet obtained by charge exchange of D_3^+. (tr-auth)

41778 NUCLEAR EXCITATIONS IN MUONIC BISMUTH. Huefner, J. (Institut fuer Theoretische Physik, Heidelberg). Phys. Lett., 25B: 189-92(Aug. 21, 1967).

Nuclear excitations might be responsible for the large quadrupole hyperfine splitting and the anomalous intensity ratios observed in muonic Bi. Isomer shifts and magnetic moments of some excited nuclear states may be measurable in Bi. (auth)

41779 DISPERSION CORRECTIONS TO THE LEVELS OF MUONIC ATOMS. Cole, R. K. Jr. (Stanford Univ., California). Phys. Lett., 25B: 178-80(Aug. 21, 1967).

The contributions of discrete nuclear states to the dispersion (nuclear polarization) corrections to the levels of muonic atoms may be calculated in a model-independent way by observing that experimental inelastic electron scattering cross-sections provide the necessary nuclear matrix elements. Expressions are derived for the contributions of the nuclear giant resonances and numerical estimates obtained for the dipole case. (auth)

41780 BROADENING OF THE INTERSECTION CURVES OF LEVELS OF THE $6\,^3P_1$ STATE OF ^{199}Hg BY COLLISIONS WITH RARE GAS ATOMS. Faroux, Jean-Pierre (CNRS, Paris). Compt. Rend., Ser. A and B, 264: 1573-6(June 5, 1967). (In French).

The broadening of the intersection of the (F, m_F), ($\frac{3}{2}$, $-\frac{3}{2}$), and ($\frac{1}{2}$, $+\frac{1}{2}$) levels of ^{199}Hg by collisions with atoms of helium and neon was measured. The results are in very satisfactory agreement with theoretical predictions. (tr-auth)

41781 ABSOLUTE MEASUREMENTS OF ELASTIC CROSS SECTION FOR SMALL-ANGLE SCATTERING OF ELECTRONS FROM N_2 AND O_2. Fink, M. (Indiana Univ., Bloomington); Kessler, J. J. Chem. Phys., 47: 1780-2(Sept. 1, 1967).

Absolute elastic cross sections are measured by electron scattering for N_2 and O_2 at 37 and 60 kV. The angle range was 5 to 70 mradians. The comparison between the measurements and the theory (atomic independent model) gives fairly good agreement for angles larger than 30 mradians. For smaller angles considerable deviations are found. Two qualitative arguments are given to show that these differences are due to chemical binding in these diatomic molecules. (auth)

41782 EXCITATION EFFECTS OF Fe^+ IN HIGH-ENERGY COLLISIONS. Layton, J. K. (General Atomic Div., General

Dynamics Corp., San Diego, Calif.). J. Chem. Phys., 47: 1869-70(Sept. 1, 1967).

Fe^+ ions were formed by electron bombardment ionization of thermally produced Fe vapor. The ions were accelerated and mass analyzed before entering a chamber in which collisions with aniline, oxygen, and water took place. The electron energy in the ion source was varied to produce different excited states of the ions, and the effect of excitation energy on the charge-transfer cross sections was studied. In the case of aniline the charge-transfer cross section decreased as the energy of excitation increased. The opposite was true for the reaction with oxygen. No excitation dependence was observed for collisions with water, although the cross section was very large compared to those of the other gases. (A.G.W.)

41783 ION–MOLECULE REACTIONS AT ENERGIES ≤ 30 eV. Fink, Richard D.; King, John S. Jr. (Amherst Coll., Mass.). J. Chem. Phys., 47: 1857-9(Sept. 1, 1967).

Molecular-beam techniques were used to study the reactions of argon ions with molecular hydrogen and deuterium in the energy range 6 to 30 eV. The velocity spectra of product ions from the reactions $Ar^+ + H_2 \rightarrow ArH^+ + H$ and $Ar^+ + D_2 \rightarrow ArD^+ + D$ were measured in order to determine whether at these energies a long-lived intermediate complex was formed or whether a direct process such as a pickup or stripping mechanism was operative. At higher energies the results agreed reasonably well with the pickup model, but at lower energies deviations appeared that were opposite in direction to those predicted by the intermediate-complex model and therefore could not be attributed to complex formation. Possible explanations of the deviations are considered. (A.G.W.)

41784 INELASTIC SCATTERING OF N_2^+ BY HELIUM. Gentry, W. R.; Gislason, E. A.; Mahan, B. H.; Tsao, Chi-wing (Univ. of California, Berkeley). J. Chem. Phys., 47: 1856-7 (Sept. 1, 1967).

In a study of scattering of 90-eV N_2^+ by helium, the anticipated elastic scattering was found at angles less than 30° in the cms, but the N_2^+ detected at angles between 50 and 180° had clearly undergone inelastic scattering with a relative kinetic-energy loss of up to 3.4 eV. The magnitude and continuous variation of this energy loss suggests that the projectile N_2^+ acquires substantial rotational and vibrational energy as a result of the collision with helium. Studies of the exact nature of the process involved are continuing. (A.G.W.)

41785 DIRECT MEASUREMENT OF AN ATOMIC QUADRUPOLE MEMENT. Angel, J. R. P.; Sandars, P. G. H.; Woodgate, G. K. (Clarendon Lab., Oxford). J. Chem. Phys., 47: 1552-3(Aug. 15, 1967).

The apparatus used for experiments on hyperfine structure transitions in the $^2P_{\frac{3}{2}}$ state of Al is basically a standard atomic-beam machine using separated Ramsey rf loops. While the atom is in the region between the rf loops, it passes through an inhomogeneous electric field. The interaction of the atomic quadrupole moment with this field gives rise to a shift in the resonance frequency. Quadrupole frequency shifts of order 100 Hz in an applied field gradient of 4×10^4 V/cm^2 were observed. The quadrupole shifts were distinguished from the quadratic Stark shifts by a digital-analysis technique that made use of the fact that the quadrupole shift changes sign with reversal of the applied electric field but the quadratic Stark effect does not. From the weighted mean of 15 determinations the quadrupole moment of the $^2P_{\frac{3}{2}}$ state of Al was found to be $+2.53 \pm 0.15ea_0^2$. This compares with a theoretical Hartree–Fock value of $2.8ea_0^2$. (A.G.W.)

41786 ATOMIC SCREENING CONSTANTS FROM SCF FUNCTIONS. II. ATOMS WITH 37 TO 86 ELECTRONS. Clementi, E.; Raimondi, D. L.; Reinhardt, W. P. (IBM San Jose Research Lab., Calif.). J. Chem. Phys., 47: 1300-7(Aug. 15, 1967).

Minimal basis-set atomic functions for the ground-state atoms from Rb(Z = 37) to Rn(Z = 86) are presented. These functions are analyzed in order to obtain systematic data for the screening constants and atomic radii following the work initiated by Slater. (auth)

41787 CONTINUOUS SPECTRA OF ATOMIC GASES AND PLASMA. Biberman, L. M.; Norman, G. E. (Scientific-Research Inst. of High Temperatures, Moscow). Usp. Fiz. Nauk, 91: 193-246(Feb. 1967). (In Russian).

A review is presented of the current theoretical and experimental state of research on the continuous spectra of a low-temperature plasma and atomic gases. Only many-electron atomic systems are considered, and principal attention is paid to the near infrared, visible, and ultraviolet bands. The formation of the continuous spectrum as a result of various electron transitions (free and bound) and as a result of coalescence and vanishing of discrete levels at the edges of the series are discussed. Sections dealing with photoionization and with electron transitions in the field of a neutral atom deal with methods of calculating the cross sections for the individual transitions, summarize the theoretical and experimental results, and discuss possible causes of observed discrepancies. The sections dealing with the resultant recombination and bremsstrahlung spectra and with summary spectra are devoted to the superposition of a considerable number of individual continua and to comparison of theory with experiment. The possible use of the results for an analysis of the spectra of nonequilibrium gases and plasma are discussed in the concluding section, which deals also with multiphoton processes. (ATD)

41788 ON THE DETERMINATION OF INCOHERENT SCATTERING FUNCTION S (V). Ghumman, B. S.; Anand, S.; Sood, B. S. (Punjab Univ., Chandigarh, India). Curr. Sci. (India), 36: 484(Sept. 20, 1967).

Gamma rays of 145 keV from ^{141}Ce were scattered from targets of Sn, Fe, Cu, and Al in the form of circular annular rings. The scattering angle was varied from 3 to 16° by changing the source–detector distance. As the energy of the incoherently scattered gamma rays is almost the same as that of the coherently scattered gamma rays, the result obtained gave the total cross sections. (W.D.M.)

41789 SECONDARY ION EMISSION. Fogel, Ya. M. (Physical-Technical Inst., Kharkov). Usp. Fiz. Nauk, 91: 75-112(Jan. 1967). (In Russian).

A review is presented of the insufficiently studied phenomenon of secondary ion emission, defined as emission of ions from a solid surface as a result of momentum transfer from the primary bombarding ions to particles existing in the solid surface. The topics covered are the determination of the sputtering coefficients of the secondary ions, which serve as a measure of secondary emission, the mass spectrum of secondary-ion emission and its behavior under variation of the target temperature and of the surrounding gas, the energy spectrum of the secondary ions and its response to various factors (energy and nature of primary ions, nature and temperature of target, type of secondary ions, etc.), the mechanism of secondary ion emission (the nature of which is shown to be still inconclusive), and various applications. (ATD)

41790 MASS-SPECTROMETRIC STUDY OF IONS IN Xe, Kr, Ar, Ne AT PRESSURES UP TO 40 torr: THERMOLECULAR FORMATION OF THE RARE-GAS MOLECULAR IONS. BOND DISSOCIATION ENERGY OF Ar_2^+ AND Ne_2^+. Kebarle, P.; Haynes, R. M.; Searles, S. K. (Univ. of Alberta, Edmonton). J. Chem. Phys., 47: 1684-91(Sept. 1, 1967).

The positive ions obtained from alpha-particle irradiation of the rare gases Xe, Kr, Ar, Ne were studied in the pressure range 5 to 40 torr. In all cases both the rare-gas molecular ion R_2^+ and the atomic ion R^+ could be observed. The R_2^+/R^+ ratio could be decreased by the addition of gases that react with R_2^+ and R^+ through charge transfer. This technique led to a determination of the rate constant for the termolecular reaction $R^+ + 2R \rightarrow R_2^+ + R$. The rate constant for argon is 6×10^{-32} cm^6 atom^{-2} sec^{-1}. The ratio of Hornbeck–Molnar ionization to direct ionization in Ar was found equal to 0.4. Xe_2^+ is a major ion in Kr (at 20 torr) containing 10 ppM xenon. The kinetics of the efficient formation of Xe_2^+ is examined. It is concluded that Xe_2^+ is formed by $Kr_2^+ + Xe \rightarrow KrXe^+ + Kr$ followed by $KrXe^+ + Xe \rightarrow Xe_2^+ + Kr$. The rate constants for these two reactions are estimated at 10^{-10} cm^3 molecule^{-1} sec^{-1}. Both reactions must be exothermic. A schematic representation of the energies of formation of the Kr, Xe, homo- and heteronuclear ions is given. Changes in the charge-transfer spectrum of ethylene with change of the concentration ratio of R_2^+ and R^+ are used to derive the ethylene charge-transfer spectrum due to R^+ and R_2^+. The charge-transfer spectrum with R^+ is in agreement with that obtained from experiments using low pressures and near-thermal velocity R^+. The charge-transfer spectrum due to R_2^+ is used in conjunction with the breakdown graph of ethylene to obtain the recombination energy R.E. of R_2^+. The bond-dissociation energy of R_2^+ is then estimated from $D(R^+–R) = I.P.(R)–R.E.(R_2^+)$. Values between 1.5 and 2 eV are obtained for the dissociation energies of Ar_2^+ and Ne_2^+. (auth)

41791 ION–MOLECULE REACTIONS IN THE XENON-SENSITIZED IONIZATION OF ETHYLENE. Kebarle, P.; Haynes, R. M. (Univ. of Alberta, Edmonton). J. Chem. Phys., 47: 1676-83(Sept. 1, 1967).

Xenon was irradiated with alpha particles in the absence of electric fields at pressures up to 40 torr containing 10^{-3} to 5 torr ethylene. Part of the gas bled into a mass spectrometer. Experiments with a movable collimating slit and a theoretical treatment of the conditions in the ion source established a qualitative picture for the sampling conditions and ionic reaction times. Most of the detected ions originated from a 1-mm-radius volume directly over the leak. The average ionic reaction-times were a few milliseconds. Electrons were sampled with greatly reduced efficiency or not at all. The xenon-sensitized ionization of ethylene produced mostly $C_2H_4^+$ as primary ion. The reactions of $C_2H_4^+$ with ethylene at xenon pressures above 10 torr led mainly to the simple chain

$C_nH_{2n}^+$ (n = even). Approximate rate constants for the addition reactions were determined. $C_4H_8^+$ added at least 100 times more slowly to ethylene than $C_2H_4^+$. Further decreases of rate constants occurred as the chain developed such that the rate constant for the $C_{10}H_{20}^+$ addition to ethylene was some four orders of magnitude lower than that of $C_2H_4^+$. At lower xenon pressures stabilization of the excited addition product $(C_nH_{2n})^+$ was not sufficiently rapid and decomposition C_kH_{2k-1} (k = odd) occurred. The stabilization to decomposition ratio was studied as a function of xenon pressure. (auth)

41792 EFFECT OF BOND FORMATION ON ELECTRON SCATTERING CROSS SECTIONS FOR MOLECULES. Kohl, D. A.; Bonham, R. A. (Indiana Univ., Bloomington). J. Chem. Phys., 47: 1634-46(Sept. 1, 1967).

Total differential scattering cross sections were obtained experimentally for molecular hydrogen, nitrogen, and oxygen. The cross section for helium was also measured and compared with a calculated cross section to calibrate the apparatus. The calculation of the binding energy from the data was carried out and compared with previous results. It was found that the scattering method with presently available experimental and theoretical techniques cannot give values comparable in accuracy to other methods for obtaining the binding energy itself but it is useful as a test of scattering theory. The binding energy obtained for hydrogen was in good agreement with the spectroscopic value. The binding energies obtained for nitrogen and oxygen were considerably higher than the accepted values. The experimental uncertainties were quite large but even so the results suggest that there may be significant deviations from the simple theory. Information about the molecular densities was obtained, which may serve as a useful check of theoretically calculated wave functions. The data were not sufficiently accurate and numerical methods have not been developed to a point where quantitative calculations of the electron densities could be made from the experimental data. The relevant theoretical quantities needed for comparison with experiment are not yet available. Qualitative arguments indicate the observed intensities are consistent with what is known about the effect of binding on molecules. (auth)

41793 THEORY OF SEQUENTIAL DECAYS. Goldhaber, Alfred S. (Univ. of California, Berkeley); Watson, Kenneth M. Phys. Rev., 160: 1151-64(Aug. 25, 1967). (UCRL-17458).

The theory of sequential decays of an unstable system is studied. Examples include the sequential emission of two or more photons by an excited atom which reaches its ground state via one or more intermediate levels, and the decay of an unstable particle into other unstable particles. To describe these phenomena, a factorization of the Green's function is introduced. This leads to a simple, and intuitively obvious, description of sequential decays. It also makes possible an assessment of the accuracy of this description. (auth)

41794 TRANSITION FORM FACTORS IN THE H ATOM. Barut, A. O.; Kleinert, Hagen (Univ. of Colorado, Boulder). Contract AFOSR-30-65. Phys. Rev., 160: 1149-51(Aug. 25, 1967).

Transition form factors between arbitrary excited states of the H atom were evaluated in closed highly symmetric form within the framework of the noncompact dynamical group O(4,2). (auth)

41795 MEASUREMENT OF ATOMIC LIFETIMES BY THE HANLE EFFECT. deZafra, R. L.; Kirk, W. (State Univ. of New York, Stony Brook). Amer. J. Phys., 35: 573-82(July 1967).

An experiment is described which utilizes the Hanle technique for measurement of atomic excited-state lifetimes, with particular application to the $^3P_1$ state of mercury. The components for the experiment are comparatively inexpensive or readily constructed, and the technique is one of the few which directly illustrate features of the interaction between radiation and free atoms. A simple classical description of the effect is given, followed by a more detailed quantum description, as well as constructional details of an experimental arrangement suitable for an advanced undergraduate or graduate laboratory. (auth)

41796 SECONDARY ELECTRON EMISSION FROM THIN SELF-SUPPORTING FILMS OF SILVER. Malat, V. (Charles Univ., Prague). Czech. J. Phys., 17: 516-20(1967).

The measurement of secondary electron emission and the scattering of primary electrons on thin self-supporting films of Ag are considered. The measured values of the practical range agree with the older results obtained by Kanter. New results are those concerning the maximum depth from which the primaries are scattered back to the front surface and the maximum range of secondaries, which has been found to be about 300 Å. (auth)

41797 ANGULAR DEPENDENCE OF RESONANCE SCATTERING OF LOW-ENERGY ELECTRONS BY N_2. Ehrhardt, H.; Willmann, K. (Univ., Freiburg i.B.). Z. Phys., 204: 462-73(1967). (In German).

Results of scattering experiments with monochromatic electrons in the energy range from a few tenths of an eV to about 16 eV are reported. Below 1.8-eV collision energy no resonance structures have been found either in the total scattering (transmitted current) or in the elastic and inelastic differential cross sections. The resonances above 1.8 eV have been measured in the elastic and inelastic channels (up to vibrational quantum number $\nu = 8$ of the N_2 molecule) in the angular range from 10° to 110°. In the inelastic channels $\nu \geq 2$ especially the first resonance peak appears asymmetric, as predicted by calculations of the associated Franck–Condon factors. In all inelastic channels the angular dependence (due to the pure resonance scattering) shows maxima at 0° and 90° and a minimum around 55°. Excitation functions of three states of N_2 were measured between their thresholds (between 11 and 12 eV) and 15 eV, one of them showing several new resonance structures. (auth)

41798 ON THE THEORY OF THE NONLINEAR COMPTON EFFECT. III. Kronig, R. (Technological Univ. of Delft, Netherlands). Ark. Fys. Seminar Trondheim, No. 6, (1967).

The quadratic Compton effect is considered for the case of an incident plane electromagnetic wave containing two different frequencies. It is shown that the scattering of x rays can be increased by 100% or more if the scattering sample is simultaneously subjected to optical radiation of an intensity such as is furnished today by solid-state lasers. (auth) (NORW)

41799 EMISSION SPECTRA OF RARE GASES EXCITED BY α PARTICLES IN THE PRESENCE OF A CONSTANT ELECTRIC FIELD. Teyssier, Jean-Louis; Blanc, Daniel; Boutot, Jean-Pierre (Centre de Physique Nucleaire, Toulouse). J. Phys. (Paris), 28: 427–32(May-June 1967). (In French).

To plot the emission spectrum of rare gases excited by a low-activity alpha source, a single electron spectrophotometer is used. When a constant electric field is applied, the intensity of the bands or continuum present in the spectrum of argon, argon–nitrogen mixture, or xenon, is sensibly increased. This is an excitation of electrons accelerated by the field. (auth)

41800 ON THE THEORY OF THE NONLINEAR COMPTON EFFECT. II. Kronig, R. (Technological Univ. of Delft, Netherlands). Ark. Fys. Seminar Trondheim, No. 5, 1967.

Previous results for the scattering cross section in the quadratic Compton effect are extended to the case that the incident monochromatic wave is circularly polarized or unpolarized. (auth) (NORW)

41801 ISOTOPE SHIFT IN Cr I. Heilig, K.; Wendlandt, D. (Technische Hochschule, Hanover). Phys. Lett., 25A: 277-8 (Aug. 14, 1967).

In transitions of the type $3d^54s - 3d^54p$ a difference in field shift of 4.4×10^{-3} cm^{-1} was found for the isotope pairs 54, 52 and 52, 50. This result signifies a jump of field shift at the closed neutron shell N = 28. (auth)

41802 NEW METHOD FOR MEASURING ELECTRON IMPACT IONIZATION CROSS SECTIONS OF INNER SHELLS. Glupe, G.; Mehlhorn, W. (Univ., Munster, Ger.). Phys. Lett., 25A: 274-5(Aug. 14, 1967).

Relative and absolute electron impact ionization cross sections of the K shell of C, N, O, and Ne have been measured for electron energies from $E_p = 1.5\ E_K$ to $E_p = 4800$ eV. (auth)

41803 LIFETIMES OF 4^1P_1, 4^1D_2, 5^1D_2, 4^3F_4 LEVELS OF CALCIUM EXCITED BY ELECTRON IMPACTS. Chenevier, M.; Dufayard, J.; Pebay-Peyroula, J. C. (CNRS, Grenoble, France). Phys. Lett., 25A: 283-4(Aug. 14, 1967).

The Hanle effect method has been used to measure the lifetime of some excited states of calcium. The experiments have been realized by means of an atomic beam of calcium excited by slow electrons. (auth)

41804 CALCULATION OF FOCUSING OF CHARGED BEAMS BY PERIODIC FIELDS. Fateev, A. P. Radiotekh. Elektron., 11: 940-2(May 1966). (In Russian).

A new simple method is suggested for determining the modulation of charged beams moving in a stationary periodic magnetic (or electric) field. The particle motion is described in terms of accelerator theory. First, a balanced trajectory (orbit) of particles that repeats itself periodically in the magnetic field is found. Then, this trajectory stability is tested, i.e., the nature of oscillations in its neighborhood is determined. The trajectory stability corresponds to the beam focusing; its instability, to defocusing. Thus, the stability analysis permits finding the conditions corresponding to optimal beam parameters. The Mendel equation that describes charged-particle paths in a longitudinal axisymmetrical magnetic field is used; it takes into account the

space charge of the beam. The method is also suitable for calculating any periodic system, such as a quadrupole-lens system. (ATD)

41805 ANALYSIS OF AXIALLY SYMMETRIC ELECTRON BEAMS FOCUSED BY PERIODIC ELECTROSTATIC FIELDS. Siladi, M. (Inst. of Technical Physics, Budapest). Radiotekh. Elektron., 11: 870-8(May 1966). (In Russian).

A detailed theoretical analysis was made of the configuration of an axially symmetric paraxial electron beam with a large current density focused by a periodic electrostatic field. A simple equation describing the distribution potential approximated the field of the system consisting of series diagrams with periodically alternating potentials. Precise computations of optimum focusing conditions were developed using a computer. A large number of electron trajectories with various-size parameters were also calculated. Analysis of the nonoptimum focusing revealed additional fluctuations in the beam boundary. Analytical expressions were derived for the fluctuation wave length and its amplitudes. For a nonparallel influx into the system the beam configuration is described by a simple formula. (tr-auth)

41806 TEMPERATURE DEPENDENCE OF LARGE-ANGLE ELECTRON SCATTERING AT POLYCRYSTALLINE GOLD FOILS. Boersch, H.; Niedrig, H.; Yersin, H. (Technische Univ., Berlin). Phys. Lett., 25A: 195-6(Aug. 14, 1967).

The temperature behavior of forward scattered, absorbed, and backscattered electrons at gold foils had been investigated. The increasing intensity of the primary beam for decreasing temperature corresponds to a decreasing intensity of the large angle forward. (auth)

41807 DYNAMIC NUCLEAR POLARIZATION OF PAKE DOUBLETS. Verber, C. M.; Lecander, R. G. (Battelle Memorial Inst., Columbus, Ohio). Phys. Lett., 25A: 179-80 (Aug. 14, 1967).

In a dynamic nuclear polarization experiment, when the center of the microwave transition is saturated, the low- and high-frequency peaks of a Pake doublet should exhibit negative and positive polarization, respectively. (auth)

41808 POLARIZABILITY OF HELIUM IN THE $2\,^3S$ STATE. Sklarew, R. C.; Callaway, J. (Univ. of California, Riverside). Phys. Lett., 25A: 177-8(Aug. 14, 1967).

The electronic polarizability, α, and dipole shielding factor, γ, were calculated for helium in the metastable $2\,^3S$ state using Hartree-Fock perturbation theory, yielding $\alpha = 322\ a_0^3$, and $\gamma = 1.0000$. (auth)

41809 SUM RULE CRITERION IN COHERENT SLOW NEUTRON SCATTERING IN LIQUIDS. Desai, R. C.; Yip, S. (Massachusetts Inst. of Tech., Cambridge). Phys. Lett., 25A: 211-12(Aug. 14, 1967).

The fourth frequency moment of the dynamic structure factor $S(\kappa,\omega)$ is computed for liquid argon. It is pointed out that two recently proposed phenomenological prescriptions for calculating $S(\kappa,\omega)$ imply certain approximations to this exact result. These are compared and discussed. (auth)

41810 MOLECULAR BEAM KINETICS: REACTIONS OF K, Rb, AND Cs WITH Br_2 AND I_2. Birely, J. H.; Herm, R. R.; Wilson, K. R.; Herschbach, D. R. (Harvard Univ., Cambridge, Mass.). J. Chem. Phys., 47: 993-1004(Aug. 1, 1967).

Crossed-beam studies have been made of the reactions of K, Rb, and Cs atoms with Br_2 and of K and Cs with I_2. It is found that for all these systems the reaction cross sections are remarkably large, $\simeq$150 Å^2. Most of the alkali halide product recoils into the forward hemisphere with respect to the incident alkali atom beam, with scattering angle $\theta \simeq 60°$ (in the center-of-mass system). However, there also appears to be considerable intensity (~20% of the forward peak) throughout the backward hemisphere, $90° < \theta < 180°$. The angular distribution (in the cms) of alkali atoms scattered without reaction falls off much more rapidly at wide angles than for collisions between unreactive molecules of comparable size. The shape of the angular distributions of both the reactive and nonreactive scattering is the same for various alkali metals, but differs appreciably for Br_2 and I_2. Most of the chemical energy released appears as internal excitation of the products. This could include substantial rotational and/or electronic excitation, but other evidence shows that vibrational excitation of the newly formed bond is dominant. All these properties can be accounted for by a model (suggested originally by Polanyi and Magee), which assumes that the attacking alkali atom transfers its valence electron to the halogen at large distances ($\simeq$7 Å), so that these are in effect ion-recombination reactions. (auth)

41811 ASYMPTOTIC RELATIONS BETWEEN THE THOMAS-FERMI-DIRAC AND THOMAS-FERMI ATOM MODELS. I. CASE OF LOW ATOMIC NUMBER. Gilvarry, J. J. (Ames Research Center, Moffett Field, Calif.); Hartle, R. E.; March, N. H. J. Chem. Phys., 47: 1029-35(Aug. 1, 1967).

An asymptotic relation between the pressure with exchange on the Thomas-Fermi model, obtained by Gilvarry for the limit of vanishing atomic number Z, is derived by a direct physical argument. As compared to the original derivation, this procedure obviates the need for solutions of the differential equations of the models and for discussion of termination of the series so obtained. The virial theorem is used to delimit the domain of validity of the result, and thus to indicate the circumstances under which correction terms are necessary from the solution of March and the general asymptotic solution of Rijnierse for the Thomas-Fermi-Dirac equation at small atom radius. The limiting form for the radius of an isolated Thomas-Fermi-Dirac atom as a function of the atomic number in the case where Z approaches zero is determined on the basis of the Jensen boundary condition. This expression yields an immediate interpretation of the parameter entering the connection between the pressures with and without exchange. The results are discussed in terms of homology transformations of the Thomas-Fermi-Dirac and Thomas-Fermi equations. Corresponding asymptotic forms for other thermodynamic functions (parameters associated with the energy and the equation of state, as well as the compressibility) are considered also for the case of vanishing atomic number. (auth)

41812 ANALYSIS OF "LOCK-IN" DETECTION OF MODULATED MOLECULAR BEAMS SCATTERED FROM SOLID SURFACES. Yamamoto, S.; Stickney, R. E. (Massachusetts Inst. of Tech., Cambridge). Contract DA28-043-AMC-02536(E). J. Chem. Phys., 47: 1091-9(Aug. 1, 1967).

The "lock-in" technique (i.e., narrow-band amplification and phase-sensitive detection) for detecting modulated molecular beams is analyzed for the case of scattering from solid surfaces. A general method is described for computing A_n and Φ_n, the amplitude and phase of the output signal. Since this computation requires the assumption of a gas-solid collision model, three different models were selected for a comparative study. Special consideration is given to the "hard-cube" model [Logan and Stickney, J. Chem. Phys., 44: 195 (1966)]. Numerical results are presented (a) to illustrate the dependence of A_n and Φ_n on the nature of the collision model and the experimental conditions, and (b) to indicate the limitations of present interpretations of experimental data. (auth)

41813 SCATTERING OF LOW-ENERGY ELECTRONS FROM POLAR MOLECULES. Crawford, Oakley H. (Queen's Univ., Belfast). J. Chem. Phys., 47: 1100-4(Aug. 1, 1967).

Differential and total cross sections are predicted for low-energy collisions of electrons with polar molecules. The potential is due to a point dipole fixed to the molecule at its center of mass, the molecule is treated as a rigid rotator, and the first Born approximation is used. Each type of polar rigid rotator is treated (linear, symmetric top, and asymmetric top) and free radicals are discussed briefly. Reference is made to swarm experiments to indicate the validity of the theory. (auth)

41814 PRESSURE-DEPENDENT CHARACTERISTICS OF AN OAK RIDGE-TYPE DUOPLASMATRON ION SOURCE. II. COMPOSITION OF HYDROGEN IONS. Watanabe, Masanori (Matsushita Electric Industrial Co., Ltd., Osaka). Jap. J. Appl. Phys., 6: 1127-35(Sept. 1967).

A measurement of the abundance ratio of mass species of hydrogen ion beam extracted from an Oak Ridge-type duoplasmatron ion source was made with a mass spectrometer and processes leading to the formation of each ion are discussed. Each ion current of H_1^+, H_2^+, and H_3^+ can reach a value of 70% or more of extracted beam current depending on the operation conditions. The atomic ion current increases as the arc current increases and it becomes dominant when the spacing between intermediate electrode and anode is small. While, the triatomic ion current is dominant at small arc currents and small magnetic field strengths particularly when the gas pressure is high and the spacing between the intermediate electrode and anode is large. The molecular ion current is dominant only at low gas pressures. In contrast with the case of an rf ion source the atomic ions are formed by two-stage processes, namely the reactions, $H_2 + e \rightarrow H_2^+ + 2e$ and subsequent $H_2^+ + e \rightarrow H_1^+ + H_1 + e$, and have an important role. The triatomic ions are produced through the ion-molecule reaction, $H_2^+ + H_2 \rightarrow H_3^+ + H_1$. (auth)

41815 ENERGY OF ION FORMATION BY CHARGED PARTICLES IN GASES. Isaev, B. M.; Gordeev, I. V.; Bregadze, Yu. I.; Gerasimov, Yu. S.; Antipenkova, G. N. Izmer. Tekh., No. 4, 3-13 (Apr. 1967). (In Russian).

The average energy of ion formation ϵ is defined as the ratio of the initial energy of an incident particle E_0 to the total number of ion pairs J formed after stopping of the particle in a substance: $\epsilon =$

E_0/J. The experimental and theoretical studies dealing with the determination of the energy of ion formation have been reviewed and systematized to give the most reliable results. Particular attention has been devoted to the region of low energies of heavy charged particles, where the value of ϵ tends to rise. Average weighted values of ϵ for various beta and gamma emitters in different media were found to be as follows: 36.6 ± 0.3 in H_2, 32.7 ± 0.3 in CO_2, 26.7 ± 0.2 in C_2H_4, 25.7 ± 0.1 in C_2H_2, 27.7 ± 0.2 in CH_4, 24.9 ± 0.2 in C_2H_6, 26.2 ± 0.5 in C_3H_8, 42.2 ± 0.3 in He, 36.2 ± 0.3 in Ne, 26.3 ± 0.2 in Ar, 24.3 ± 0.2 in Kr, 22.0 ± 0.2 in Xe, 34.8 ± 0.2 in N_2, and 30.9 eV ± 0.2 in O_2. Averaged values of ϵ for alpha particles and protons in various media were as follows: 35.0 ± 0.04 in air, 36.2 in H_2, 34.2 in CO_2, 28.03 in C_2H_4, 27.5 in C_2H_2, 29.1 in CH_4, 26.6 in C_2H_6, 26.3 in C_3H_8, 36.9 in Ne, 26.3 in Ar, 24.3 in Kr, 21.9 in Xe, 36.30 in N_2, 32.4 in O_2 and 35.6 eV in BF_3. The value of ϵ increased for heavy nuclei of low energy. (TTT)

41816 SPECTRA OF O IV AND O V. Bromander, Jan (Univ. of Uppsala); Johansson, Bertil; Bockasten, Kjell. J. Opt. Soc. Amer., 57: 1158-9(Sept. 1967).

A 2-kJ theta pinch discharge was used as a light source. Spectrograms were taken in the region 400 to 2200 Å with a Hilger 3-m normal incidence vacuum spectrograph and in the region 2200 to 8000 Å with an Ebert spectrograph. (M.O.W.)

41817 ION-BOMBARDMENT LEVEL-CROSSING SPECTROSCOPY. Kaul, R. D. (Lewis Research Center, Cleveland). J. Opt. Soc. Amer., 57: 1156-7(Sept. 1967).

Ion-bombardment techniques were used to extend the range of excited states that can be studied by level-crossing spectroscopy Results are given for the $n^3P_0-n^3P_1$ level separation in helium with n = 3,4,5,6. (M.O.W.)

41818 AUTOIONIZATION RESONANCE LINES OF HIGHLY IONIZED ATOMS OF THE Na I ISOELECTRONIC SEQUENCE. Feldman, Uri; Cohen, Leonard (Goddard Space Flight Center, Greenbelt, Md.). J. Opt. Soc. Amer., 57: 1128-9(Sept. 1967).

Resonance lines originating from autoionization energy levels far above the ionization potential have been observed for highly ionized atoms from Ti to Cu. Two of the lines for each ion have been classified as the transitions $2s^2\ 2p^6\ 3s\ ^2S_{1/2}-2s^2\ 2p^5\ 3s^2\ ^2P^0_{3/2,1/2}$, of the Na I isoelectronic sequence. Wavelength and energy tables are given and a typical spectrogram is presented. (auth)

41819 LETNYAYA SHKOLA PO PROBLEMAM TEORII ELEMENTARNYKH CHASTITS, KYAYARIKU 1965. CHASTITS I. (Proceedings of the 1965 Summer School on Elementary Particle Physics held at Kaariku, Estonian SSR, August 16–29, 1965. Volume 1). Palgi, L.; Yiglane, Kh. (eds.). Tartu, Institute of Physics an Astronomy, Academy of Sciences, Estonian SSR, 1966. 172p.

Three papers were included. Separate abstracts were prepared for each paper. (J.F.P.)

For abstracts of individual papers see: 41820, 42329, and 42373.

41820 PROCESSES IN HEAVY μ-MESIC ATOMS. Ignatenko, A. E. pp 109-134 of Letnyaya Shkola Po Problemam Teorii Elementarnykh Chastits, Kyayariku 1965. Chastits I. Palgi, L.; Yiglane, Kh. (eds.). Tartu, Institute of Physics and Astronomy, Academy of Sciences, Estonian SSR, 1966. (In Russian).

The processes occurring during the formation of heavy μ-mesic atoms were reviewed. The nuclear dimensions were derived and the effects of fine structure were determined. The effects of quadrupole interactions of muons with nuclei were also determined. The excitation of nuclei during radiationless transition of muons into mesoatoms was described. (J.S.R.)

41821 TOTAL THERMAL ENERGY CROSS SECTION MEASUREMENTS FOR THE SCATTERING OF ALKALI ATOMIC BEAMS BY ALKALI GASES AND PLASMAS IN THERMODYNAMIC EQUILIBRIUM. Gray, Edward. New York, New York Univ., 1966. 253p.

Thesis.

Attenuation measurements were made for the scattering of velocity-selected thermal energy lithium and potassium beams by cesium gas, cesium and potassium crossed-beams, and by a highly ionized cesium plasma. The velocity dependence, over the beam speed range 1000 to 3000 meters/sec., of the attenuation of a lithium beam by a cesium plasma at 2073°K was studied at five apparatus resolving powers (0.58 to 7.60 minutes of arc) and the data analyzed assuming that only electron–atom and iron–atom elastic collisions contribute to the scattering. The attenuation velocity dependence passes through a minimum, corresponding to 50%–50% scattering due to ions and electrons, as the resolving power is made increasingly poorer. (Disser. Abstr.)

41822 POSITRON ANNIHILATION IN RARE EARTH SINGLE CRYSTALS. Williams, Ronald Wendell. Ames, Iowa, Iowa State Univ. of Science and Tech., 1966. 84p. (IS-T-112).

Thesis.

The angular correlation curves of positron annihilation radiation from positrons annihilating in c-axis-oriented single crystals of yttrium, gadolinium, terbium, dysprosium, holmium, erbium, and holmium–50% erbium and b-axis-oriented single crystals of yttrium and holmium were measured. The curves show the highly anisotropic nature of the Fermi surface and are found to be consistent with a model recently proposed by Loucks. A connection between the occurrence of antiferromagnetism in the metals and particular features of their Fermi surfaces is suggested. Humps occur in the angular correlation curves of dysprosium, holmium, and erbium c-axis-oriented single crystals at room temperature and are indicative of flat electron and hole regions of their Fermi surfaces, which run parallel to one another and normal to the c-axis. No humps appear in the curves of gadolinium and terbium c-axis-oriented crystals at room temperature and this suggests a modification of this particular feature of the Fermi surface. Those rare earth metals that have 4f electrons and whose curves have humps exhibit a relatively large temperature range of antiferromagnetism, while those rare earth metals that have 4f electrons and whose curves do not have humps either have relatively small temperature regions of antiferromagnetism or no antiferromagnetism. Thus, it appears that the occurrence of parallel flat electron and hole regions of the Fermi surface running normal to the c-axis are related to the ability of a metal to form a helical, magnetic structure. The angular correlation curve of the c-axis crystal of holmium at 60°K does not show a hump. This is believed to be due to the modification of the flat regions of the Fermi surface caused by the occurrence of a magnetic superlattice. The close correlation between the curves of holmium, erbium, and holmium–50% erbium seems to indicate that the rigid band model applies and that the concept of a Fermi surface is valid for the binary rare earth alloys with hexagonal close packed structure. (Disser. Abstr.)

41823 POSITRON ANNIHILATION IN MOLECULAR SOLIDS. Spirn, Irwin. New York, New York Univ., 1966. 112p.

Thesis.

Earlier quantum mechanical model calculations show, and experiments have confirmed, that at low and intermediate temperatures the long lifetime of orthopositronium atoms (o-Ps) against electron pickoff in a molecular lattice rises with free volume, because the overlap between the positron component of the o-Ps wave function and the wave function of the lattice electrons responsible for pickoff decreases with increasing lattice spacing. An extension of this model to higher temperatures, where the influence of lattice vibrations becomes increasingly important, predicts a shortening of the pickoff lifetime relative to its value in a cold lattice of the same free volume. In fact, under favorable conditions, on heating, the rise with free volume can be overshadowed by the decline due to thermal density fluctuations such that a maximum in the pickoff lifetime develops at a characteristic inversion temperature. In search for such maxima, lifetime spectra of positrons annihilating in three organic insulators (polyethylene, polytetrafluoroethylene, glycerol) were measured with high resolution over wide temperature ranges, and decomposed into three components. On analysis, the data reveal that the relative intensities of the components with the longest and shortest lifetimes, in their dependence on temperature and pressure, vary as the free volume. At elevated temperatures the longest lifetime in polytetrafluoroethylene exhibits a maximum interpreted to be a manifestation of the thermal motion of the lattice molecules. (Disser. Abstr.)

41824 INTERMOLECULAR POTENTIAL AND THERMAL ELASTIC SCATTERING. Luoma, John Robert Vincent. Lafayette, Ind., Purdue Univ., 1966. 234p.

Thesis.

The role of the intermolecular potential in describing crossed, thermal-energy molecular-beam experiments was studied by means of forward and inverse computations. A forward calculation entailed assuming an intermolecular potential, and, by means of a quantum mechanical analysis of the wave representation of the elastic scattering process, calculating differential and total cross sections. By means of these forward calculations, the effects of a piecewise defined intermolecular potential upon the monoenergetic total cross section and the velocity spectrum of the total cross section were studied and discussed. The potential modifications appeared to be mapped onto the phase shift curves, however, this mapping relationship was blurred by variations in the position and depth of the potential curve. Undulations in the velocity spectrum of the total cross section were discussed from the point of view of location and height of the phase shift curve. The average differential cross section was calculated from 60

monoenergetic differential cross sections and was found to be quite smooth. It was approximated excellently at small angles by the differential cross section of the central velocity. Computations simulating a velocity selector experiment, were performed. An outline of the general inversion procedure, which utilized a linearized Taylor series expansion of the fitting function in terms of its parameters coupled with a least squares procedure involving the data points, was given along with two examples fundamental to this study. The suitability of the angular scaling function and the intensity scaling function for representing the average differential cross section was discussed, as well as the applicability of these functions to an inverse scheme. Usefulness of relative differential-cross-section data for inversion was postulated and studied. Convergence of the inversion procedure for the test case of Knauer's data was reported. An unsuspected sensitivity of the average differential cross section to the intermolecular potential form was noted. Suggestions were given for improvement and expansion of the inversion of average differential-cross-section data. (Disser. Abstr.)

41825 STIMULATED COMPTON SCATTERING OF ELECTRONS BY A LASER BEAM. Roskos, Roland Rufus. Ames, Iowa, Iowa State Univ. of Science and Tech., 1966. 106p.

Thesis.

The phenomenon of stimulated Compton scattering of electrons, i.e., the diffraction of electrons by standing light waves, was predicted by Kapitza and Dirac 30 years ago. The intense standing waves set up inside a laser cavity seem well suited for an experimental test of the proposal of Kapitza and Dirac. Kapitza and Dirac derived a probability for interaction by coupling the known probability for ordinary Compton scattering with the ratio of Einstein coefficients for stimulated and spontaneous emission. This formulation was not directly applicable to representative experimental conditions in which a laser is used as a light source. Stimulated Compton scattering has since been treated in this laboratory in terms of an interaction of an electron plane wave with a perturbing potential corresponding to the standing light wave to obtain a stationary state solution to the Schroedinger equation. Probabilities of electron deflection were derived for various laboratory conditions with emphasis placed on electron beam orientation and coherence properties of the laser. A new electron diffraction unit has been designed for the observation of stimulated Compton scattering. Giant pulses in the cavity of a Q-switched ruby laser served to diffract 1640-volt electrons. The small scattering angles were measured by scanning the electrons past a slit of a scintillator detector. Theoretical demands on design of apparatus are discussed, experimental difficulties are listed, and the limitations of the apparatus are described. Numerous experiments were completed over the period of several months when the laser generated high powers. Many deflection events were obtained at both positive and negative scattering angles, which were consistent with expectations for stimulated Compton scattering. Some experiments were attempted in which the electron deflection probabilities were observed as functions of electron beam orientation and laser power. Qualitative results indicated that measurable electron deflections occurred only when the electron beam intersected intense standing light wave planes at the Bragg angle. The observed deflections also required high laser powers. All experimental observations seemed consistent with developed theory within the broad limits of experimental error. A critical test of theoretical expressions, however, was not possible because the complex distribution of energy and divergence of the laser radiation were not fully characterized. (Disser. Abstr.)

41826 APPROXIMATIONS IN THE THEORY OF REARRANGEMENT COLLISIONS AND APPLICATIONS TO A TRACTABLE MODEL OF CHARGE-EXCHANGE SCATTERING. Quong, James. Berkeley, Calif., Univ. of California, 1966. 91p.

Thesis.

The approximation ideas and methods and the historic difficulties involved with the calculation of ion–atom rearrangement scattering are examined and redeveloped. Five approximation schemes are selected to be tested. The transition probability for symmetric resonant charge exchange is calculated by these methods for a model one-dimensional scattering system whose exact solution, serving as the basis for comparison, is also attainable by numerical techniques. The impact parameter ideas concerning the uncoupling of the internal and external dynamics are built into the model. None of the high-energy theories are found to be adequate beyond the upper intermediate range; this suggests at least that the convergence of perturbation expansions is slow. The two improved first-order schemes, for which the effects of nonorthogonality have been eliminated, are adequate only at upper intermediate energies. The Born approximation always gives results too high. An exchange mechanism is found to be operative for all energies up through the intermediate range. The two two-component coupled channel schemes, one employing atomic form factors, the other molecular form factors, together cover accurately this span of the spectrum. Asymmetric resonant and nonresonant exchange are examined briefly at low and intermediate energies, to confirm predictions drawn from the previous work. The new results are that asymmetric resonant systems are qualitatively indistinguishable from symmetric resonant systems, and that the exchange mechanism is present also for nonresonant systems and may even be the controlling mechanism over the upper portion of the range of energy mentioned. At decreasing energies, however, the mechanism of the adiabatic approximation, tending to suppress exchange in nonresonant systems, becomes progressively more important and eventually becomes decisive. The formal statement, embodying the contents of the last two paragraphs, is that the coupled-channel schemes provide an adequate theory for calculating the exchange probability, within the limitation imposed by off-manifold processes, over the low and intermediate ranges of energy for all three types of scattering systems. (Disser. Abstr.)

41827 COINCIDENCE STUDY OF ARGON ION–ATOM COLLISIONS AT KILOVOLT ENERGIES. Kessel, Quentin Cattell. Storrs, Conn., Univ. of Connecticut, 1966. 99p.

Thesis.

Single collisions of Ar^+ on Ar, at 25 to 400 keV for scattering angles from 8 to 40 degrees, have been studied using a coincidence scattering apparatus. For the reaction $Ar^+ + Ar \rightarrow Ar^{+n} + Ar^{+m} + (n + m - 1)e$ the charge states n and m ($0 \leq n$ or $m \leq 8$) of both particles from the same collision were determined. The experiment found the probabilities of seeing n and m in coincidence and investigated the possibility of a correlation between n and m. In addition, simultaneous measurements of the scattered and recoil angles after collision determined the inelastic energy loss for the above reaction with n and m specified. The data show that in general, there is little or no correlation between n and m. Where correlation is found (for distances of closest approach of about 0.24 and 0.09Å), the data suggest that it may be attributed to levels of excitation existing in argon atoms. The data also show the average inelastic energy loss of the reaction usually increases when either the energy of the incident particle or the scattering angle is increased. A similar increase in the inelastic energy loss for the reaction with n and m specified was found. (Disser. Abstr.)

41828 MODEL FOR CHARGE TRANSFER IN NONADIABATIC COLLISIONS. Ellison, Walton Darrell. New York, New York Univ., 1964. 107p.

Thesis.

A model for charge transfer during low-energy collisions of atomic systems that exhibit pseudocrossing of the potential energy surfaces is taken as $h_{nn} = h_{mm} = V_0 \exp[-\beta(R - R_c)]$ and $h_{mm} - h_{nn} = \Delta E \{1 - \exp[-\beta(R - R_c)]\}$ where h_{pq} are the matrix elements of the interaction, R is the separation of the atomic nuclei, R_c is the crossing distance, and the other constants are related to those in the Landau–Zener model. The coupled differential equations for the transition amplitude are solved exactly for zero impact parameter in terms of the confluent hypergeometric function. An asymptotic expansion of this function in $(v/v_0)^{1/2}$ where v is the relative speed of the nuclei and v_0 is the speed of the electron in the first Bohr orbit shows that the transition probability becomes an oscillating function of the nuclear separation after a single transit of the crossing point. The oscillations are centered about the Landau–Zener probability. A simplification of the model leads to an expression for the total transition probability after two transits of the crossing point, which is an oscillating function of the impact parameter and of the relative speed of the atomic systems. An expression corresponding to the Landau–Zener formula for the total probability, $\mathcal{P} = 2P(1-P)$ where P is the probability after a single transit of the crossing point, does not apply for this model. Other related models are also considered and for some of these the associated coupled equations are integrated numerically. (Disser. Abstr.)

41829 ANGULAR DISTRIBUTION AND YIELD MEASUREMENTS OF SINGLE-CRYSTAL COPPER SPUTTERED BY 1- TO 10-keV CESIUM IONS. Olson, Noble Thomas. Berkeley, Calif., Univ. of California, 1966. 89p.

Thesis.

A radioactive tracer technique has been applied to the measurement of the yield and angular distribution of copper sputtered from a monocystalline target bombarded by a cesium ion beam of 1 to 10 keV. The ion beam was incident normal and at 45° to the target surface that corresponded to the (100) crystallographic plane. The sputtering yield curve at normal incidence is characterized by its low value (6.5 at 5 keV) and the maximum achieved at 5 keV with a subsequent decrease at higher energies. By contrast, the yield curve at 45° incidence had substantially higher values and increased monotonically over the entire 1- to

10-keV range. The low yield at normal incidence is a result of the openness of the (100) crystallographic face while at 45° incidence the ion penetration depth is decreased causing an increased yield. The angular distribution measurements are reported as the fractional yield per unit solid angle for the known collector positions. The angular distribution measurements show that emission in the ⟨110⟩ close-packed direction exists but is superimposed on a background distribution. An analytic function to approximate the sputtering distribution was least-mean-square-deviation fitted to the data with the ⟨110⟩ close-packed focusing represented by a Gaussian function and the background distribution represented by a cosine function. Integration of the differential sputtering distribution gave the relative contributions to the sputtering phenomenon by the ⟨110⟩ close-packed focusing (Gaussian) and the random-scattering (cosine) mechanisms. The effect of the ⟨110⟩ close-packed focusing was secondary, contributing 20% of the total at 1 keV and decreasing to 12% at 10 keV. From this energy dependence and previously measured ion penetration depths, it was possible to infer that the focusing chains are short, of the order of 5 lattice constants or less. (Disser. Abstr.)

Cosmic Radiation

41830 A VARIATION, WITH A PERIOD OF TWO SOLAR CYCLES, IN THE COSMIC-RAY DIURNAL ANISOTROPY. Forbush, Scott E. (Carnegie Inst. of Washington, D. C.). J. Geophys. Res., 72: 4937-9(Oct. 1, 1967).

An account is given of the variability of yearly means of cosmic-ray diurnal anisotropy and of its average for the period 1937–1965. The data were obtained from a pressure-corrected ion-chamber at Cheltenham– Fredericksburg (USA), Huancayo (Peru), and Christchurch (New Zealand). (J.H.M.)

41831 COSMIC-RAY PRODUCTION OF DEUTERIUM AND TRITIUM IN THE EARTH'S ATMOSPHERE. Teegarden, B. J. (Univ. of Maryland, College Park. Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 72: 4863-8(Oct. 1, 1967).

A measurement of the intensities of cosmic-ray-produced deuterium and tritium in the earth's atmosphere was made using a dE/dx and E detector flown aboard two high-altitude balloon flights launched from Fort Churchill, Manitoba, in June 1965. Using these results the global average production rate of tritium in the earth's atmosphere was obtained. The results indicate a value of 0.20 ± 0.05 tritons per second produced in a 1-cm^2 column of atmosphere. Calculations of the tritium production rate have been made by others based on machine-measured cross sections for the production of tritium in air by protons. Their results range from 0.14 to 0.37 triton/cm^2 sec. Results from this study are clearly within the range of others. (auth)

41832 THE DETECTION OF HIGH-ENERGY COSMIC-RAY SHOWERS BY THE COMBINED OPTICAL AND ELECTROMAGNETIC PULSE. Colgate, Stirling A. (New Mexico Inst. of Mining and Technology, Socorro). J. Geophys. Res., 72: 4869-79(Oct. 1, 1967).

A theoretical estimate of the electromagnetic pulse from an extensive cosmic-ray air shower shows that the deflection of the electrons and positrons of the shower in the Earth's magnetic field gives rise to a perturbed magnetic field with a forward traveling pulse whose momentum corresponds to that removed by the deflection of the charged particles. The angular divergence of this pulse is determined primarily by the curvature of the shower front corresponding to an angle of approximately $1/_{10}$ radian for low-altitude showers, increasing at greater altitude. The rise time is similarly limited by the structure of the shower front to approximately 10^8 seconds, but the decay time may be much longer because of the larger deflections at high altitude. Coincident optical radiation can be observed from the relatively wide-angle Cherenkov radiation from the sum total of the multiple-scattered shower electrons. Widely spaced optical detectors in coincidence must be used to discriminate against the more frequent lower energy single-particle or core Cherenkov events. Using these combined techniques, it is predicted that the highest energy cosmic-ray showers can be identified and their flux measured at angles nearly tangent to the Earth's surface with a frequency greater than present counter arrays. (auth)

41833 AN IMPROVED RE-ENTRANT COSMIC-RAY ALBEDO CALCULATION. Ray, Ernest C. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 72: 4839-44 (Oct. 1, 1967).

An earlier calculation of the intensity of re-entrant albedo is repeated. An error in the previous calculation is corrected, and the effects of nuclear interactions and the spiraling of trajectories are included. Improved fits to the altitude dependence of primary protons and to the Bethe Block formula are used. The previously computed value of the re-entrant albedo intensity was $j = 1.17$ (m^2 sec ster MeV)$^{-1}$ or $j = 0.47$ (m^2 sec ster MV)$^{-1}$, both at 85 MeV during December 1961 at Sioux Falls, South Dakota. The improved value is $j = 0.41$ (m^2 sec ster MeV)$^{-1}$ under the same conditions as for the previous calculations. Both calculations have omitted the contributions to the intensity of deuterons and tritons. (auth)

41834 A STUDY OF LOW-ENERGY GALACTIC COSMIC RAYS FROM 1961 TO 1965. Teegarden, B. J. (Univ. of Maryland, College Park. Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 72: 4845-56(Oct. 1, 1967).

The results from a series of balloon flights beginning in 1961 and ending in 1965 are presented. Measurements of the cosmic-ray intensity were made using a dE/dx and E detector sensitive to energies from 15 to 80 MeV/nucleon. Proton and helium intensities at 85 MeV/nucleon are presented for the five-year period covered by the balloon flight series. The behavior of the proton to helium ratio as a function of time is discussed within the framework of Parker's model for the solar modulation of cosmic rays. In 1965 a modified version of the dE/dx and E detector with an extended energy range was flown for the first time. A cosmic-ray helium spectrum from 60 to 500 MeV/nucleon measured by this detector is presented. The change in proton and helium intensities as a function of particle velocity in this energy region from 1963 to 1965 is examined and compared with the results predicted by the various special cases of Parker's model. (auth)

41835 ATMOSPHERIC SECONDARY AND RE-ENTRANT ALBEDO PROTONS. Teegarden, B. J. (Univ. of Maryland, College Park. Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 72: 4857-62(Oct. 1, 1967).

Data from a balloon-borne dE/dx and E detector are used to obtain values for the atmospheric secondary and re-entrant albedo proton intensities. Flights were made from various latitudes ranging from $\lambda = 32°$ $\lambda = 59°$ (geographic). A totally empirical atmospheric secondary proton spectrum is derived, based on simultaneous balloon and satellite measurements of the proton intensity. This spectrum is compared with the secondary spectrum obtained from a nuclear emulsion measurement, and the differences are discussed. Using an empirical secondary spectrum, an upper limit for the re-entrant albedo at Sioux Falls was obtained, which is significantly less than values reported by other observers. (auth)

41836 METEOROLOGICAL FEATURE OF COSMIC RAY PRODUCED ^{7}Be. Murayama, N. (Japan Meteorological Agency, Tokyo). J. Meteorol. Soc. Jap., Series II, 42: 43-52(1964).

All the data of beryllium-7 in air and rain produced by the interaction of cosmic rays with atmospheric constituents are surveyed from the viewpoint of their meteorological application as a tracer material. It is found that (1) the seasonal variation in concentration of ^{7}Be in rain is similar to that in air on the ground, (2) the similar but timely shifted seasonal variation which has a peak concentration in winter is evident in the upper atmosphere, and (3) the latitudinal distribution in ^{7}Be deposition which has a peak accumulation in middle latitudes is discernible. Mean residence or removal times of ^{7}Be in the troposphere and the lower stratosphere are derived to be about forty days and several months, respectively. These appearances are in good accordance with those found out in distribution and transfer of fission products in the atmosphere. (auth)

41837 ADVENTURES OF COSMIC RAYS IN INTERSTELLAR SPACE. Shapiro, Maurice M. (Naval Research Lab., Washington, D. C.). J. Wash. Acad. Sci., 57: 93-103(Apr. 1967).

Present knowledge regarding the origin, mode of generation, and properties of cosmic radiation is reviewed. Particular attention is given to cosmic rays having energies greater than 1 GeV per nucleon. Lower energy cosmic rays, those of tens or a few hundreds of MeV, are more noticeably affected by solar-system plasmas and their associated magnetic fields. Estimates of the mean thickness of material traversed by galactic cosmic rays are discussed on the basis of studies of cosmic-ray composition near the top of the earth's atmosphere, and from investigations of the chemical and isotopic transformations produced by nuclear collision with interstellar matter. These studies are related to the question of cosmic-ray age, and to the mean at. density and the extent of the regions through which the radiation passes. Cosmic-ray abundances of the light elements, and isotopic composition of cosmic-ray He are also discussed. The presence of Li, Be, and B in primary cosmic radiation is considered, as well as He isotopes in the primary radiation. Estimations of cosmic-ray age are examined. (BBB)

41838 EXTENSIVE AIR SHOWERS OF COSMIC RADIATION. Cachon, Andre; Dupuy, Jean (Observatoire du Pic, France). Nucleus (Paris), 8: 133-49(1967). (In French).

The theoretical structure of extensive air showers is reviewed. The experimental devices adapted for their study and the results obtained with them are described. In a sequence, the significance of the study of extensive air showers is discussed with respect to the expansion of data on nuclear forces and fundamental particles and astrophysics. (J.S.R.)

41839 MULTIPLICITY MEASUREMENTS OF COSMIC RAY NEUTRON MONITORS IN LOW LATITUDE. Kodama, Masahiro; Ishida, Yoshio (Inst. of Physical and Chemical Research, Tokyo). Rep. Ionosphere Space Res. Jap., 21: 55-8(1967).

Results are reported of the multiplicity measurements performed at two low-latitude stations of Itabashi (20 m, 11.5 GV) and Mt. Norikura (2770 m, 11.4 GV) using both IGY and IQSY neutron monitors during September–November, 1966. Data indicate that the detected multiplicity distribution depends greatly on both the monitor geometry and the latitude. The mean multiplicity for each monitor is summarized, together with those obtained by others at high-latitude stations, Rome (6.4 GV), Uppsala (1.4 GV), and Deep River (1.0 GV). (J.H.M.)

41840 MULTIPLE NEUTRON PRODUCTION IN THE SOLAR COSMIC-RAY INCREASE OF JANUARY 28, 1967, IN SYOWA BASE, ANTARCTIC. Kodama, Masahiro (Inst. of Physical and Chemical Research, Tokyo). Rep. Ionosphere Space Res. Jap., 21: 59-62(1967).

Information on the small cosmic-ray increase which occurred in January 28, 1967, is reported, particularly on the basis of the multiplicity effect measured by a cosmic-ray neutron monitor at Syowa Base (69.03°S, 39.60°E), Antarctica. Data are plotted from 10-minute readings of cosmic-ray neutron intensities from Syowa Base and Deep River and 10-minute and hourly readings of the multiplicity effect of the solar cosmic-ray increase at Syowa Base. (J.H.M.)

41841 ENERGY SPECTRUM OF COSMIC-RAY MUONS IN THE VERTICAL DIRECTION. Aurela, A. M. (Univ. of Turku, Finland); Wolfendale, A. W. Ann. Acad. Sci. Fenn., Ser. A VI., No. 227, 1-14(1967).

The spectrum of cosmic-ray muons was measured in the range 7.7 to 116 GeV/c by means of the Durham vertical spectrograph, which had been considerably modified since the previous measurements. The observed spectrum, based on 19,235 measurable events, agreed with the composite spectrum presented by Osborne et al., and with the spectrum measured by Bull et al. At higher energies, the underground range spectrum of Achar et al., and the underground burst-spectrum of Vernov et al., are considered. A composite spectrum is given as the present best estimate of the spectrum of sea-level muons in the energy range 1 to 7000 GeV. (auth)

41842 DOUBLE SUNSPOT-CYCLE VARIATION IN COSMIC-RAY DIURNAL VARIATION. Wada, Masami; Kudo, Shoko (Inst. of Physical and Chemical Research, Tokyo). Rep. Ionosphere Space Res. Jap., 21: 45-54(1967).

The double sunspot-cycle or 22-year variation in the phase of cosmic-ray diurnal variation is investigated by means of the loci traced by the diurnal vectors in a two-dimensional coordinate system. The data obtained by ion chambers during 1932 through 1966 were used. The 22-year variation is represented by a pair of eleven-year revolutions of the vectors. The revolution alternates its sense every eleven years. The epochs of the reversal of sense coincide with the years of minimum sunspot numbers within a year. The revolutions are separated into two components in a cartesian coordinate system on the analogy of Lissajous' figure. At least two cosmic-ray streamings with different directions in interplanetary space are necessary. There are two models of variations in the amplitudes of streaming. The first is the different phase model which requires two eleven-year variations. The sense of revolution depends on whether the phase difference between the two variations is positive or negative. The second is the different-frequency model in which the two streamings vary with periods of eleven and 22 years, respectively. If the phases coincide, the locus is a horseshoe-like trajectory. The direction of the motion alternates every eleven years. The geomagnetic activity which shows a double sunspot-cycle variation is employed at one of the representatives of variations. When the sunspot numbers are substituted for the other component, a revolutional pattern is set up for the Zürich even-numbered cycles. In the case of the odd-numbered cycles, the sense of revolution does not reverse, but is merely flattened. It should be studied further. The rigid rotation of the cosmic-ray gas with the sun and the radial flow of the cosmic-ray particles suggested by Parker may correspond to the two streamings assumed above. It is plausible to expect time variations with rather long periods as years to the two mechanisms. (auth)

41843 YEARLY VARIATION OF SOLAR ACTIVITY RELATED TO COSMIC-RAY FLARES DURING THE LAST SOLAR CYCLE, 1954–1964. Sakurai, Kunitomo (Kyoto Univ.). Rep. Ionosphere Space Res. Jap., 21: 29-44(1967).

Annual occurrence of solar flares associated with cosmic rays varies considerably with the progression of the solar activity cycle. The relative sunspot numbers (i.e., Wolf numbers) as a measure of solar activity have no relation to the above annual occurrence. The year of the maximum occurrence of solar cosmic-ray flares is not coincident with that for the relative sunspot numbers, but is delayed two to three years after the sunspot maximum years. It may be that the occurence of solar cosmic-ray flares is independent of the relative sunspot numbers. The brightness of solar corona observed by the 5303 Å green line could be, further, adopted as a new measure of solar activity. The condensation of solar corona is formed above the active areas on the solar photosphere, and the brightness there is usually much higher than that of the other regions. Thus the brightness of solar corona observed by the 5303 Å green line is considered as the other measure of solar activity. In reality, the pattern of the yearly variation of the occurrence of solar cosmic-ray flares is evidently similar to that of the brightness of solar corona during the last solar cycle, 1954 to 1964. The positions of the solar flare regions related to solar cosmic rays on the sun have a tendency to localize in some active areas fixed on the sun concerning heliographic longitude. Furthermore, the positions of the very bright areas of solar corona are coincident with those of solar cosmic-ray flare regions just mentioned. There were four such active regions during the increasing and maximum phases and two during the declining phase of the last solar activity cycle. The occurrence of solar cosmic-ray flares is closely related to the activity of solar corona as stated before. Thus a re-examination may be needed of the triggering mechanism of solar cosmic-ray flares which has been deduced earlier. Furthermore, the origin of solar cosmic-ray flares and the acceleration mechanism of solar cosmic rays are demonstrated to be closely connected with the physical condition of the solar atmosphere, especially the generation and development of the stable solar coronal condensation. It is suggested that the pattern of the yearly variation of the annual occurrence of solar cosmic-ray flares is affected strongly by the configuration of the sunspot magnetic fields in the heliographic low-latitude zone and the the general magnetic field. (auth)

41844 BACKGROUND COSMIC COUNT INCREASE ASSOCIATED WITH THUNDERSTORMS. Shaw, Glenn E. (Univ. of Arizona, Tucson). J. Geophys. Res., 72: 4623-6(Sept. 15, 1967).

An increase in the cosmic-ray component (E > 500 keV) was found to accompany thunderstorms. No correlation was found between nearby individual lightning strokes and count rate, but a general count increase with a time constant of some 10 min was found for all thunderstorms that passed nearby. Flux increases were typically 5%. The nature of the count increase is not known. (auth)

41845 TEMPERATURE EFFECT ON THE NEUTRON COMPONENT OF COSMIC RADIATION. Akhababyan, N.; Betev, B.; Stamenov, I.; Tsvetkov, Ts. (Inst. of Physics, Academy of Sciences, Bulgaria). Compt. Rend. Acad. Bulg. Sci., 20: 285-7 (1967). (In Russian).

The standard neutron monitor counts the active component of cosmic radiation, which consists primarily of neutrons at sea level. The existence of a temperature effect was sought by examining the data obtained by a standard neutron monitor operating at a height of 2925 meters (station on Musal mountain) from August of 1964 to August of 1965. The pressures and temperature were measured at the meteorological station, and the average atmospheric temperature was obtained with spherical probes sent aloft three times a day at Sofia which was 80 km from Musal Mountain. The data showed that the correlation between the neutron count and the temperature was significant. The absolute value of the temperature coefficient was not small, and a correction should be applied with strong temperature variations. The temperature effect was due to the state of the entire atmosphere and not to the state of a single atmospheric level. The average temperature was more suitable for use than the local temperature. Additional studies would be required to explain the reasons for these temperature variations. (TTT)

41846 THEORY OF RADIO PULSE PRODUCTION IN EXTENSIVE AIR SHOWERS. Allan, H. R. (Imperial Coll. of Science and Tech., London). J. Atmos. Terrest. Phys., 29: 1103-25(Sept. 1967).

Radio emission by extensive air showers is analyzed in terms of the apparent particle accelerations as seen from the radio receiving aerial. The emission is shown to be associated principally with the

transverse deflection of low-energy electrons and positrons in the geomagnetic field, but there is also appreciable radiation due to longitudinal accelerations at the beginning and end of the particle tracks. In contrast to the situation with optical Cherenkov radiation, the emission is influenced only slightly by the refractive index of air. The radio pulse waveform consists of an initial sharp pulse >0.01 μsec in duration, followed by a small-amplitude, long-duration tail of opposite sign. The pulse width increases for vertical showers as the distance from the axis increases. The corresponding frequency spectrum is fairly flat, and extends to ~20 Mc. The amplitude of the pulse is ~10 μ V/m for primary energies ~10^{16} eV. (auth)

41847 LONGITUDINAL DISTRIBUTION OF CHERENKOV LIGHT FROM EXTENSIVE AIR SHOWERS. Castagnoli, Carlo; Dardo, Mauro; Penengo, Piero (Univ., Turin). Phys. Rev., 160: 1186-9(Aug. 25, 1967).

The longitudinal development of extensive air showers of ~10^{13} eV is studied both experimentally and theoretically. The risetime and duration of Cherenkov pulses in uv light at 3500 m above sea level are studied experimentally with high-speed techniques. The results are in quite good agreement with an accurate Monte Carlo estimate in the "B" approximation of electromagnetic shower theory. (auth)

41848 DIE ENTSTEHUNG DER KOSMISCHEN ULTRASTRAHLUNG UND DAS EXPANSIONSPHAENOMEN DER WELT. (The Origin of Cosmic Radiation and the Expansion of the Universe). Bagge, Erich. Thiemig-Taschenbuecher, Band 29. Munich, Verlag Karl Thiemig KG, 1966. 68p. DM 6,80.

An hypothesis on the origin of cosmic radiation is presented. According to this hypothesis the cosmic dust present in the interstellar space becomes negatively charged by electron capture. This phenomenon leads to a negative charge of the star systems of the Milky Way and produces an electric field in intergalatic space that accelerates the cosmic particles. This electric field also affects the flight motion of the spiral cloud. Viewpoints indicating a negative charge of cosmic matter are compiled. (J.S.R.)

Direct Energy Conversion

Refer also to abstracts 41072, 41073, 41153–41155, 41158–41160, and 41861.

41849 (AD-645932) MAGNETICALLY INDUCED NONEQUILIBRIUM ELECTRON TEMPERATURES. Interim Report. Rosenstock, Herbert B. (Naval Research Lab., Washington, D. C.). Nov. 23, 1966. 19p. (NRL-6456). CFSTI.

For operation of an MHD generator at low temperatures, various methods have been proposed to enhance the ionization and hence the conductivity. The scheme is considered in which the electrons present in an MHD generator are accelerated by the magnetic field itself (to a magnetically included nonequilibrium temperature) preparatory to producing additional electrons by impact ionization. A model for the flow of a partially ionized gas in an MHD generator that combines extreme mathematical simplicity with at least qualitative physical realism is used. The derivations show that the electron temperatures attained cannot exceed the temperature that the gas had before part of its kinetic energy was converted into motion along the channel: that is, the magnetically induced nonequilibrium electron temperature cannot exceed the stagnation temperature of the gas, which is equal to the temperature of the gas at rest before being expanded through a nozzle. (auth)

41850 (AED-C-15-13) BIBLIOGRAPHIEN ZUR KERNFORSCHUNG UND KERNTECHNIK, SEKTION 15, DIREKTE ENERGIE-UMWANDLUNG. (Bibliographies in Nuclear Science and Technology, Section 15, Direct Energy Conversion). Eisert, J. (comp.) (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). May 1967. 106p. (In German and English). Dep.

A listing of approximately 370 articles on various direct energy conversion devices is presented. (M.O.W.)

41851 (AEEW-M-755) USE OF DUST SUSPENSIONS IN CLOSED CYCLE MAGNETOHYDRODYNAMIC ELECTRICAL GENERATION SYSTEMS. Hooper, A. T.; Newby, D. (Atomic Energy Establishment, Winfrith (England)). July 1967. 32p. Dep. CFSTI. UK.

A study leading to the selection of a reference design, and its first cost estimates for a closed cycle nuclear MHD plant, is described. The chosen working fluid is a suspension of barium oxide in argon, and the peak cycle temperature is 2000°K. The predicted economics of this cycle offer little incentive to embark on the large amount of development necessary, but the methods used in arriving at this conclusion are relevant to the assessment of other MHD cycles. As the theoretical work was nearing completion, results from the experimental program initiated in the earliest days of the project showed that the physics model for the calculation of electrical conductivity of a dust laden gas is inapplicable under the conditions necessary for MHD work; under these conditions, severe agglomeration problems occur. (auth) (UK)

41852 (KFK-584) PHYSIK UND GEPLANTE ANWENDUNGEN DES THERMIONISCHEN KONVERTERS. (Physics and Planned Uses of Thermionic Converters). Karow, Hans-Ulrich (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Apr. 1967. 21p. (In German). Dep.

An attempt is made to give a concise review of the physical model for thermionic conversion and the possible uses of thermionic converters. (tr-auth)

41853 (JPRS-41939) PROSPECTS FOR MAGNETOHYDRODYNAMIC PROPULSION OF SHIPS. Baranov, A. P. Translated from Sudostroenie, No. 12, 3-6(1966). 9p. (TT-67-32570). CFSTI.

A comparison is made of the effectiveness and compactness of an MHD-driven propulsion unit with a conventional direct electric current electric motor and installation and the aspects for the application of drives that use MHD principles of operation are evaluated. (M.O.W.)

41854 PLASMA PHYSICS OF THERMIONIC CONVERTERS. Bullis, Robert H. (United Aircraft Research Labs., Hartford); Hansen, Lorin K.; Warner, Charles; Houston, John M.; Koskinen, Michael F.; Rasor, Ned S. J. Appl. Phys., 38: 3425-38(Aug. 1967).

The plasma physics of thermionic converters is discussed in an attempt to develop a coherent physical picture of this aspect of the converter in all regions of operation. Emphasis is placed on the presentation of simple physical models consistent with experimental data: The usefulness of certain characteristic features of the I–V curve, in determining the physical processes governing converter operation, is pointed out. Nine regions of converter operation are identified by these features of the I–V curve and are discussed. The importance of two parameters of converter operation, the pressure–spacing product pd, and the relative amount of emitter-surface ion generation β, in controlling converter behavior is emphasized. The particular values of pd and β control which of the nine regions of converter operation appear on a particular I–V curve. (auth)

41855 FACTORS INFLUENCING ELECTRO-FLUID DYNAMIC POWER GENERATION. Brandmaier, Harold E.; Dimmock, T. Herbert (Curtiss-Wright Corp., Wood-Ridge, N. J.). J. Spacecraft Rockets, 4: 961-6(Aug 1967).

In electrofluiddynamic power generation, gasdynamic forces are used to transport charged particles against an opposing electric field. The fraction of the enthalpy converted into electrical energy increases with increasing gas density and decreasing charged-particle mobility. A closed-cycle generator was developed consisting of a reciprocating compressor, accumulator, heat exchanger, and generator. With a ½-in.-i.d. generator, approximately 1.6 lb of air can be circulated at a stagnation pressure of 700 psia and a generator inlet Mach number of 0.4. Experimental data show that power output increased with increasing pressure level; however, it decreased with increasing length to radius ratio, contrary to theoretical predictions. During these experiments one million volts were indicated at a load current of μA. In a small open-cycle generator operating at a 1.5 inlet Mach number and a fixed load resistance, increasing the moisture content of the air increased the power by a factor of 23.5. (auth)

41856 PERFORMANCE OF SPACE POWER LIQUID METAL MHD CYCLES UTILIZING A TWO-PHASE FLOW GENERATOR. Petrick, Michael; Roberts, John J. (Argonne National Lab., Ill.). J. Spacecraft Rockets, 4: 967-73(Aug. 1967).

A comprehensive study has been made of two-phase liquid metal MHD generators incorporated in one- and two-component cycles. Included in the analysis is a realistic appraisal of friction losses and two-phase conductivity limitations. The concept of fluid recycle to limit the void fraction within the generator is proposed, and the effect on cycle efficiency is determined. Under the assumptions of this study, the two-component Li–Cs system has a realizable efficiency of 10%, which is higher than has been calculated for other liquid metal MHD power cycles that have been proposed for space power application. For the one-component cycle, the maximum efficiency that can be demonstrated is 8%. This efficiency is obtained with extensive recycle of the $K_{0.4}-Hg_{0.6}$ working fluid. Serious limitations on obtainable voltage and electrical efficiency of liquid metal MHD generators are shown to

exist. These are due entirely to cycle considerations and electrical shunt losses. In order to achieve attractive voltage and generator efficiencies, the analysis shows that the electrical end losses must be reduced by at least 80%. (auth)

41857 EFFECT OF THE INTERNAL SHORT CIRCUITING ON ELECTRICAL CHARACTERISTICS OF MHD POWER GENERATORS WITH PEG WALLS. Sasaki, Yutaro (Hitachi Ltd., Tokyo). Jap. J. Appl. Phys., 6: 1145-53(Oct. 1967).

The effect of the internal short circuiting caused by metal pegs embedded in insulating walls for an MHD power generator results in the reduction in open-circuit voltage; it makes no change in short-circuited current in the absence of the Hall effect. Electrical characteristics of generators with peg walls are expressed in terms of a correction factor, which represents a rate of the reduction in open-circuit voltage. It is shown that this factor can be determined theoretically by the use of a conformal mapping technique or experimentally by means of an electrolytic bath. Experimental results obtained with a combustion-driven MHD power generator reveal that this effect is not minor even in the presence of thermal boundary layers near peg walls and that it can be minimized by coating alumina on the surface of metal pegs. (auth)

41858 INVESTIGATION OF AN ARGON-FILLED THERMIONIC GENERATOR. Bacal, Martha; Cristescu, Maria; Voci, C. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 12: 114-16(1967).

Curves are plotted for the I–V characteristics of a thermionic generator operating at an argon pressure of 3.5 torr with emitter and collector at 1000°C. The characteristics are analyzed, and the results are discussed. (J.H.M.)

41859 ANALYTICAL DESCRIPTION OF THE ARC MODE OPERATION OF THERMIONIC CONVERTER. Geavit, Musa (Inst. of Physics, Bucharest). Rev. Roum. Phys., 12: 69-77 (1967).

The plasma potential drop, gas temperature drop, and electron temperature drop in low-voltage plasma are considered in an analytical correlation of the plasma parameters not requiring an ion generation mechanism. Useful relations for the plasma potential drop evaluation are obtained. An equation for electron temperature distribution in low-voltage are plasma is obtained. The relations derived are useful in the analysis of the low-voltage arc mode operation of thermionic converters. (auth)

41860 ELEMENTS OF ENERGY CONVERSION. Russell, C. R. Oxford, Pergamon Press, 1967. 416p. 60s.

Information is presented on all important aspects of energy conversion, and devices employed, in terms of fundamental thermodynamics. Main headings are as follows: energy; thermal properties and relations; heat engines, chemical energy; electrochemical processes; solar energy; thermoelectricity; thermionic generators; radioisotope power sources; and energy storage. (UK)

41861 ADVANCES IN ENERGY CONVERSION ENGINEERING. Papers Presented at 1967 Intersociety Energy Conversion Engineering Conference, August 13–17, 1967, Miami Beach, Florida. New York, American Society of Mechanical Engineers, 1967. 1016p. (CONF-670806).

Advanced concepts of energy conversion systems for power production are presented. The brayton cycle, rankine cycle, thermionics, thermoelectrics, photovoltaics, electrochemical devices, hydrogen-oxygen fuel cell, magnetohydrodynamics and electrogasdynamics, chemical engines and turbines, and nuclear energy sources are the energy conversion concepts discussed. Among the applications of these concepts are manned and unmanned nuclear space power systems, underwater power, unconventional terrestrial power, and electric automobile power. 98 papers are presented. 46 are abstracted; two were previously abstracted under numbers 21 : 29076, 21 : 30173 and 21 : 32295. Papers for which no abstracts were prepared concern the following general topics: photovoltaics, electrochemical devices, hydrogen–oxygen fuel cells, chemical engines and turbines, thermodynamics and new concepts, and electric automobile power. (M.L.S.)

For abstracts of individual papers see: 41069–41073, 41102–41111, 41153–41160, 41862–41872, 42788, 42798–42807, and 42836.

41862 EVALUATION OF A SET VIII THERMIONIC GENERATOR. Fry, Joseph F. (Goddard Space Flight Center, Greenbelt, Md.). pp 151-61 of Advances in Energy Conversion Engineering. New York, American Society of Mechanical Engineers, 1967.

From 2nd Intersociety Energy Conversion Engineering Conference, Miami Beach, Fla., Aug. 13–17, 1967. See CONF-670806.

The operational and long term performance characteristics of a SET VIII thermionic electric power generator for space applications are presented. The sensitivity of the power output to changes in operating parameters and the degradation of power output with time were obtained in order to evaluate the practicability of the generator for space applications. The generator was operated for a total of 3000 hours at design and off-design conditions producing a maximum power output of 108 watts at an overall measured efficiency of 7.6%. One diode failed at this point and was removed from the electrical circuit. The generator was placed back on test and after an additional 250 hours a second diode failed and the test was terminated. (auth)

41863 ANOMALOUS ELECTRON AND ION CURRENTS IN PLASMA-MODE OPERATION OF A THERMIONIC ENERGY CONVERTER. Shimada, Katsunori; Luebbers, Scott S. (California Inst. of Tech., Pasadena). pp 177-80 of Advances in Energy Conversion Engineering. New York, American Society of Mechanical Engineers, 1967.

From 2nd Intersociety Energy Conversion Engineering Conference, Miami Beach, Fla., Aug. 13–17, 1967. See CONF-670806.

Operation of a thermionic energy converter in the applied-voltage quadrant has shown the presence of a higher-current mode of discharge (plasma mode). Measurement of the heating power required to maintain a constant emitter temperature at various current levels has permitted the separation of electron and ion currents. Electron currents several orders of magnitude higher than predicted by existing theories are recorded. The bi-stable nature of a thermionic converter operating in the plasma mode has made possible its application as a high-temperature switch. (auth)

41864 THERMIONIC CONVERTERS WITH HEAT-PIPE RADIATORS. Brosens, Pierre (Thermo Electron Engineering Corp., Waltham, Mass.). pp 181-7 of Advances in Energy Conversion Engineering. New York, American Society of Mechanical Engineers, 1967.

From 2nd Intersociety Energy Conversion Engineering Conference, Miami Beach, Fla., Aug. 13–17, 1967. See CONF-670806.

An analysis of heat-pipe dynamics is conducted to develop criteria for the design of thermionic converter heat-pipe radiators and the selection of their working fluid. The evolution of the design of a particular thermionic converter prototype is presented in order to demonstrate the progress of heat-pipe technology, and the reduction in thermionic converter weight made possible by the application of heat pipes. The first version of this prototype used conduction heat transfer in its collector–radiator structure, and, after thorough design optimization through the construction of several models, it weighed 320 grams. An initial model of the heat-pipe version of the same prototype appeared to be well optimized and weighed only 78 grams. (auth)

41865 DESIGN AND DEVELOPMENT OF A HIGH EFFICIENCY CASCADED AND SEGMENTED THERMOELECTRIC MODULE. Rocklin, S. R. (Atomics International, Canoga Park, Calif.). pp 207-19 of Advances in Energy Conversion Engineering. New York, American Society of Mechanical Engineers, 1967.

From 2nd Intersociety Energy Conversion Engineering Conference, Miami Beach, Fla., Aug. 13–17, 1967. See CONF-670806.

Analytical studies have shown that significant performance improvements can be achieved by combining SiGe and PbTe materials in a manner such as to allow use of each material over its maximum operating temperature range. A module using SiGe elements and PbTe segmented elements in a cascaded configuration has been designed and is under development. The design utilizes SiGe elements metallurgically bonded to an interstage plate which in turn serves as the hot plate for the PbTe stage. The PbTe stage uses segmented elements contained in a hermetically sealed enclosure filled with an inert gas. A tension stud and spring assembly is used to maintain the PbTe elements under compressive load and provide thermal contact between the plate and the PbTe element hot shoe. With the SiGe stage operated between 1840 and 1100°F and the PbTe stage between 1000 and 400°F, the module efficiency is in excess of 10% at a specific power of 38 watts/lb. (auth)

41866 RADIATION DAMAGE TO THIN SILICON SOLAR CELLS. Martin, J. H. (Johns Hopkins Univ., Baltimore); Statler, R. L.; Ralph, E. L. pp 289-96 of Advances in Energy Conversion Engineering. New York, American Society of Mechanical Engineers, 1967.

From 2nd Intersociety Energy Conversion Engineering Con-

ference, Miami Beach, Fla., Aug. 13–17, 1967. See CONF-670806.

Generally 2 ohm-cm solar cells are capable of producing more power in a radiation-free environment than are 10 ohm-cm cells. After exposure to irradiation doses greater than 5×10^{15} 1 MeV electrons/cm^2, 10 ohm-cm cells have more power capability due to the lower degradation rate. Thin 10 ohm-cm cells deliver constant power for longer time in a radiation environment than do the other types of cells. The "oil can" effect inherent to very thin cells indicates the presence of mechanical stresses in the metal-semiconductor sandwich. Although these stresses are present in all solar cells, regardless of thickness, the greater flexibility of very thin wafers allows bending without fracture. While the flexibility could be advantageous in roll-up array designs, the stresses may result in problems when the cells are subjected to thermal cycling. After extensive irradiation cells of a given base resistivity behave similarly, regardless of wafer thickness. (auth)

41867 DESIGN DATA FOR COAL-BURNING OPEN-CYCLE MHD SYSTEMS. PART I. EFFECT OF SLAG FORMATION ON DUCT OPERATION AND SEED RECOVERY. Feldmann, Herman F.; Simons, William H.; Bienstock, Daniel (Bureau of Mines, Pittsburgh). pp 423-9 of Advances in Energy Conversion Engineering. New York, American Society of Mechanical Engineers, 1967.

From 2nd Intersociety Energy Conversion Engineering Conference, Miami Beach, Fla., Aug. 13–17, 1967. See CONF-670806.

A mathematical model is presented which allows the computer computation of the amount and composition of both the plasma and liquid slag phases from the combustion of "seeded" coal. Electrical and thermodynamic data for the plasma–liquid slag mixtures from the combustion of a potassium-seeded high-volatile bituminous coal are calculated using the model, and the boundary between the plasma region and plasma–liquid slag regions determined. The mechanisms of seed loss in the slag are discussed, and the amount of seed loss as a function of controllable system parameters is presented. Computer data showing the effect of seed level and type on combustor temperatures, plasma electrical conductivity, and air pollution are also presented. (auth)

41868 CONTROL IN HOT SURFACE CHANNELS FOR OPEN CYCLE MHD GENERATORS,. Yerouchalmi, D. (CEA, Paris); Anthony, A. M.; Foex, M. pp 431-4 of Advances in Energy Conversion Engineering. New York, American Society of Mechanical Engineers, 1967.

From 2nd Intersociety Energy Conversion Engineering Conference, Miami Beach, Fla., Aug. 13–17, 1967. See CONF-670806.

An investigation was made of materials for insulating walls and spacers in MHD channels. Samples of $SrZrO_3$ and $CaZrO_3$ were prepared for the study. Consideration is given to the influence of impurities on various properties of the materials. A schematic section of a channel insulating wall design is shown. (J.H.M.)

41869 MAJOR PROBLEM IN ELECTROFLUID DYNAMIC POWER GENERATION. Brandmaier, Harold E. (Curtiss-Wright Corp., Wood-Ridge, N. J.). pp 457-64 of Advances in Energy Conversion Engineering. New York, American Society of Mechanical Engineers, 1967.

From 2nd Intersociety Energy Conversion Engineering Conference, Miami Beach, Fla., Aug. 13–17, 1967. See CONF-670806.

The major problem in electrofluid dynamic power generation is the low ratio of fluid energy converted into electrical energy Δ h/ho. Analytical estimates and recent experimental data are reviewed; these indicate a ratio of the order of 10^{-4} for a single-stage generator. The effects of Mach number, charged particle mobility, pressure level, and radial space charge field on the load characteristic and Δ h/ho are discussed. Finally, possible methods for increasing Δ h/ho are considered. (auth)

41870 CHARGE GENERATION BY CORONA DISCHARGE IN ELECTROFLUIDDYNAMIC ENERGY CONVERSION PROCESSES. Decaire, John A.; Wifall, James R. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). pp 465-71 of Advances in Energy Conversion Engineering. New York, American Society of Mechanical Engineers, 1967.

From 2nd Intersociety Energy Conversion Engineering Conference, Miami Beach, Fla., Aug. 13–17, 1967. See CONF-670806.

A corona discharge is investigated as the charging process for an electrofluiddynamic generator. With air as the primary working medium, ion current magnitudes are determined for a variety of flow conditions and electrode geometries. The results are related to some basic theoretical considerations. Preliminary test results for the generation of charged particle currents by condensation around ions are also presented. (auth)

41871 INVESTIGATION ON POWER GENERATION USING ELECTROFLUIDDYNAMIC PROCESSES. Lawson, Maurice O.; Decaire, John A. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). pp 473-83 of Advances in Energy Conversion Engineering. New York, American Society of Mechanical Engineers, 1967.

From 2nd Intersociety Energy Conversion Engineering Conference, Miami Beach, Fla., Aug. 13–17, 1967. See CONF-670806.

The influence of charge spreading on the electrofluiddynamic generator channel performance is investigated for representative channel geometries. The performance of these channels is compared with that of the classical one-dimensional channel. Required total properties of the working medium are derived in terms of the stage efficiency, loss parameter, gas velocity, and channel geometry. (auth)

41872 RECENT STUDIES OF ADVANCED COAL BURNING POWER PLANTS. Young, W. E. (Westinghouse Research Center, Pittsburgh); Way, S.; Tsu, T. C.; Hoover, D. Q.; Cochran, N. P. pp 485-92 of Advances in Energy Conversion Engineering. New York, American Society of Mechanical Engineers, 1967.

From 2nd Intersociety Energy Conversion Engineering Conference, Miami Beach, Fla., Aug. 13–17, 1967. See CONF-670806.

The plant arrangement and anticipated performance of a large open-cycle MHD-steam power plant are discussed. The plant is assumed to burn a char produced from coal. The char fuel is especially attractive for MHD generation because of its low hydrogen content. This leads to lower concentration of alkali hydroxide in the products and leaves more alkali atoms free for ionization, also fewer negative (OH^-) ions are formed so that electron density is improved. The net result is a 40 to 60% increase in electrical conductivity of the combustion products, as compared to coal, for a given air preheat temperature. Either a shorter generator duct or a lower air preheat temperature may therefore be realized. The char burning plant considered would reach about 52% overall efficiency, at about 800 MW rating. Top temperature would be 2640°K (4300°F). In the combustion process envisaged here, a two stage combustor would be used, in order to reject a major fraction of the ash constituents before the gases go into the generator. That ash which does go through the system, and which may attach a fraction of the seed as aluminum silicates, could be recycled to the combustion chamber. In this way, seed loss by entrapment with fly ash is kept to a minimum. An application of this type of plant of considerable current interest would be to use it in conjunction with a coal–gas plant for production of pipe line gas or liquid fuels. The char fuel is produced in such plants and can be burned in a power plant on the same site. There are several combinations and arrangements which are briefly described. Outstanding problems calling for further investigation are discussed. (auth)

Fluid Physics

Refer also to abstracts 41748 and 41904.

41873 (AD–645107) CHARACTERISTIC EQUATIONS FOR A SUPERSONIC FLOW PROBLEM WITH MAGNETOHYDRODYNAMIC EFFECTS. Loper, F. C.; Lightsey, M. B. (Arnold Engineering Development Center, Arnold Air Force Station, Tenn.). Jan. 1967. Contract AF40(600)-1200. 22p. (AEDC-TR–66–206). CFSTI.

A derivation of the characteristic equations for supersonic inviscid flow with magnetohydrodynamic (MHD) forces present is given for the two-dimensional and axisymmetric cases. Workable forms of the equations relating the MHD effects are indicated for the axisymmetric problem. (auth) (TAB)

41874 (AD–645632) GASDYNAMIC METHODS IN MAGNETOHYDRODYNAMICS. Final Report, January 1, 1963–December 31, 1966. Cap, F.; Falser, H.; Friedel, H.; Herrnegger, F.; Kerer, G. (Innsbruck Univ. (Austria). Institut fuer Theoretische Physik). Dec. 31, 1966. Contract AF61(052)-675. 108p. (AFOSR–67-0151). CFSTI.

In order to investigate the applicability and extension of gasdynamic methods for MHD flow, the generalization of the Crocco theorem for plasmas and the conditions for potential flow in a plasma with infinite electrical conductivity were derived. Next two-dimensional steady and one-dimensional unsteady potential flows were investigated by the graphical characteristics and by variational methods. Then two-dimensional steady and one-

dimensional unsteady problems for a plasma with finite electrical conductivity were solved and the new methods were applied to a travelling wave plasma accelerator, to crossed-field accelerators, and to magnetic nozzles. It was shown that the new methods can be applied also to Hall propulsion devices, to MHD generators, and to viscid plasma flows with nonvanishing heat conductivity and with varying electric conductivity. (auth) (TAB)

41875 (AD-647885) ON NUMERICAL RESULTS OF A ONE-DIMENSIONAL UNSTEADY VARIATIONAL METHOD IN MGD. Report No. Scientific-40. Herrnegger, Franz (Innsbruck Univ. (Austria). Institut fuer Theoretische Physik). Dec. 30, 1966. Contract AF61(052)-675. 33p. (AFOSR-67-0677). CFSTI.

It is shown that the variational principle corresponding to the potential equation for unsteady MGD flows lends itself to a direct numerical evaluation of the variational functional with the aid of the Ritz method, leading thus to the construction of an approximate analytic solution for the velocity potential in the case of certain initial value problems. (auth)

41876 (CEA-R-3137) SUR LES CHOCS DANS UN MILIEU MAGNETODYNAMIQUE REACTIF AVEC APPLICATION AU PROBLEME DU PISTON. (Shocks in Magneto-Reactive-Gas-dynamics With Application to the Piston Problem). Soubbaramayer (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1967. 110p. (In French). Dep. Thesis. Submitted to Univ., Paris.

Four types of detonation and four types of deflagration waves in magnetogasdynamics are considered. The propagation of these waves is not always completely determined by the initial-boundary conditions and the conservation laws across the discontinuity. The piston problem is considered and it is shown that in some cases more conditions must be added to the conservation laws in order to provide sufficient data for the unique determination of the propagation process. It is then shown that the needed additional conditions may be derived from an investigation of the internal structure of the detonation and deflagration process in magnetogasdynamics. This internal structure is investigated for the eight types of process under the influence of the combustion mechanism and the dissipative coefficients (viscosities, electrical and thermal conductivity). Finally all the possible solutions for the piston problem are discussed in a simple case. The methods developed here may be extended to ionizing shocks. (auth)

41877 (LA-DC-8789) COMPUTER STUDIES OF TIME DEPENDENT FLOWS. Hirt, C. W. (Los Alamos Scientific Lab., N. Mex.). [1966]. Contract W-7405-eng-36. 4p. (CONF-670933-1). Dep. CFSTI.

From AGARD Seminar on Numerical Methods for Viscous Flows, Teddington, England.

A discussion of finite difference approximations to the full, time-dependent, Navier-Stokes equations is presented. A fluid is visualized as flowing through a network of stationary rectangular cells, and for each cell of the network, values are assigned for the average mass, momentum, and energy. These values are advanced in time by calculating net fluxes through all surfaces. The basic Eulerian approach is introduced by considering a simple linear convection equation. Several alternative finite difference approximations are compared. They lead to the important result that truncation errors associated with a finite difference approximation are good indicators of computational stability and accuracy. This result is quite general and its consequences for approximations of the Navier-Stokes equations are explored. (M.H.R.)

41878 STABILITY OF A MAGNETOHYDRODYNAMIC HALF-JET. III. INVISCID STABILITY OF A COMPRESSIBLE MAGNETOHYDRODYNAMIC HALF-JET. Lessen, Martin; Deshpande, Narayan V. (Univ. of Rochester, N. Y.). Phys. Fluids, 10: 1968-73(Sept. 1967).

The inviscid stability of the laminar mixing of an infinitely conducting compressible fluid in the presence of an aligned magnetic field is investigated with respect to two-dimensional wavy disturbances. It is found that an increase in the Mach number increases the wave speed of a neutrally stable disturbance for all values of the magnetic field. With increasing Mach numbers the wavelength of a neutral disturbance increases for weak magnetic fields while it decreases for strong magnetic fields. The inviscid flow is unstable. (auth)

41879 STABILITY OF QUASI-SINGLE-DIMENSIONAL MAGNETOHYDRODYNAMIC (MHD) FLOWS. Slobodkina, F. A. Prikl. Mat. Mekh., 31: 406-15(May-June 1967). (In Russian).

Equations of continuity, flow, and energy of nonstationary, single-dimensional flow are written at small magnetic Reynolds numbers. In order to investigate the stability of flow, a linearized set of equations is introduced with small perturbations in the density, velocity, and pressure of the ideal gas. The electric and magnetic fields are arbitrary functions of the distance x along the axis. The perturbed parameters are functions of x and the time t. Three types of flow are investigated: (1) supersonic, (2) subsonic, and (3) transitional from the sonic to the shock wave region. The region of instability at particular values of the frequency is analyzed from general solutions of the equation for stationary flow. The conditions of instability are defined for subsonic flow, supersonic flow (shock wave), and for transitional flow from subsonic to supersonic flow. (TTT)

41880 NATURE OF BOUNDARY LAYERS AND THEIR OVERLAPPING DURING THE MAGNETOHYDRODYNAMIC FLOW OF A CONDUCTING FLUID IN A RECTANGULAR DUCT. Grinberg, G. A.; Kontorovich, O. M. Prikl. Mat. Mekh., 31: 564-7 (May-June 1967). (In Russian).

The flow of a conducting fluid in a rectangular duct with nonconducting walls within a transverse magnetic field was studied by applying Green's function. The velocity and the induced magnetic field distributions, especially near the walls, lying parallel with the external magnetic field were investigated, especially for the range of high Hartman numbers and for areas near to the intersection of the various boundary layers. The obtained solution was compared with the values obtained by means of J. A. Shercliff's approximation, using an asymptotic representation for the Macdonald function. It was found that, within the examined range, the values obtained by means of the approximation formula are close to the exact ones. (TTT)

41881 UNSTEADY MAGNETOHYDRODYNAMIC FLOW PAST THIN BODIES WITH INWARDLY DIFFUSING MAGNETIC FIELD. Fan, Dah-Nien (Cornell Univ., Ithaca, N. Y.). Phys. Fluids, 10: 1756-68(Aug. 1967).

A rational small-perturbation theory is proposed for treating an initial- and boundary-value problem in magnetohydrodynamic flow past thin symmetrical bodies with the thickness parameter ϵ as the perturbation parameter. An irrotational flow over the body is established initially in the total absence of electromagnetic interactions. The fluid is assumed to be incompressible, inviscid, and electrically conducting. Moreover, it is bounded by two infinite parallel planes outside which vacuum prevails. The external magnetic field is then imposed by turning on current sheets of constant intensity at the fluid-vacuum boundaries. The zeroth- and first-order solutions are obtained analytically for an arbitrary body shape. The establishment of Lary's steady flow past a thin body at super- or sub-Alfvénic conditions, the existence of small-perturbation solutions at exactly Alfvénic flows, and the appearance of an accumulation point of poles to characterize the transient behavior of a physical system are the interesting features which emerge in the course of the present work. (auth)

41882 MAGNETOHYDRODYNAMIC BOUNDARY LAYERS WITH VARIABLE PROPERTIES. Gribben, R. J. (Univ. of Strathclyde, Glasgow). Phys. Fluids, 10: 1849-50(Aug. 1967).

Boundary layers in fluids, whose diffusivities of vorticity ν, heat κ, and magnetic field η satisfy $\nu << \kappa << \eta$ have thicknesses differing in order of magnitude. Uniformly valid solutions are obtained by matching series for each layer at the two interfaces. (auth)

41883 APPROXIMATE SOLUTION FOR CERTAIN UNSTEADY BOUNDARY LAYER PROBLEMS CONSIDERING MAGNETIC FIELDS. Sharikadze, Dzh. V. (Tbilisi State Univ., USSR). Soobshch. Akad. Nauk Gruz. SSR, 45: 43-6(Jan. 1967). (In Russian).

Magnetohydrodynamic equations are developed for the unsteady flow of a viscous, incompressible, finite-conductivity fluid over a two-dimensional plate. (R.V.J.)

41884 THERMALLY DRIVEN NONLINEAR OSCILLATIONS IN ONE-DIMENSIONAL MAGNETOHYDRODYNAMIC FLOW. Gundersen, Roy M. (Univ. of Wisconsin, Milwaukee). Int. J. Eng. Sci., 4: 563-82(Oct. 1966).

A tube containing an ideal, inviscid perfectly conducting monatomic compressible fluid subjected to a transverse magnetic field has a plane heater at its midsection and energy is supplied externally. When the frequency of a sinusoidal heat release is equal to twice the resonance frequency of the tube, the resultant nonlinear vibrations increase with time, shock waves are formed and ultimately the perturbation attains a limiting value. The perturbed flow field and the motion of the resultant shock waves are studied by the use of a characteristic perturbation method due to Lin. The analysis is based upon the work of Chu and Ying, which is contained as a special case of the solution of the present paper. (auth) (IAA)

41885 MAGNETOHYDRODYNAMIC FLOW AT A REAR STAGNATION POINT. Leibovich, S. (Cornell Univ., Ithaca, N. Y.). J. Fluid Mech., 29: 401-13(Aug. 11, 1967).

An exact rear stagnation point solution is sought for a viscous, incompressible conducting fluid in the presence of a magnetic field. It is found that a steady solution exists only if $N \geq 2$, where $N = \sigma B^2/\rho\alpha$ is the interaction parameter of the flow based upon the normal component of the magnetic field at the wall. Here α is a positive rate of strain, which, for a finite body with length l and velocity U_0, is of the order of U_0/l. The steady solution is found, and from its existence it is inferred that separation of the viscous boundary layer does not begin at the rear stagnation point when $N \geq 2$, and that such separation can be prevented. This supports theoretical work by Moreau (1964) and experimental work of Tsinober, Shtern & Shcherbinin (1963). When $N < 2$, the flow is necessarily unsteady, and in this case an asymptotic analysis (as $t \rightarrow \infty$) similar to that of Proudman & Johnson (1962) is undertaken. For $N < 1$, the magnetic and non-magnetic flows are qualitatively alike, in that there is a growing inviscid region dominated by eddies, and an ultimately steady layer at the wall representing a viscous forward stagnation point flow. For $1 < N < 2$, the inviscid region again grows with time, but no eddies appear. It is thus suggested that for this range of N separation occurs without reversed flow. (auth)

41886 TIMING OF SONOLUMINESCENCE FLASH. West, C. D.; Howlett, R. (Atomic Energy Research Establishment, Harwell, Eng.). Nature (London), 215: 727(Aug. 12, 1967).

The phenomenon of the sonoluminescent flash is sometimes observed in acoustic cavitation, and theories attempting to explain its origin can be divided according to whether they predict the flash to occur at the moment of birth or collapse of the bubble. Experiments are described in which cavitation bubbles were nucleated by fast neutrons from a pulsed source. The time delay between neutron burst and flash emission was observed, using a 100-channel time sorter on 1-μsec channels. It was found that the flash was not emitted during the burst (time of nucleation and initial growth of the bubble), but on the average more than half a period of the sound wave later. The experimental technique employed is described. The rise time of flash was observed to be not greater than 12 nsec. (UK)

41887 SOME MAGNETOHYDRODYNAMICS OF A THIN BODY IN PERPENDICULAR FIELDS. Greenberg, Paul (London Univ.). Z. Angew. Math. Phys., 18: 523-8(July 25, 1967).

The steady motion of a compressible, inviscid fluid, which is a perfect electric conductor, past a thin conducting body in the presence of a magnetic field is studied. This field, when undisturbed, is uniform and perpendicular to the undisturbed velocity field. The lift and drag are calculated; and the lift is plotted for various values of the Mach and Alfvén numbers, M and A respectively, for a body of zero thickness. (M.H.R.)

41888 BOLTZMANN TREATMENT OF ELECTRON TRANSPORT IN MAGNETOHYDRODYNAMIC FLOW. Still, Duncan Allan. Berkeley, Calif., Univ. of California, 1966. 156p.

Thesis.

A theoretical study of an electron gas is made here to find possible ways to enhance the electrical conductivity of a gas (for use in a magnetohydrodynamic converter). This work is based upon the Boltzmann transport equation. It is assumed that the electron gas is sufficiently dilute so that the interaction between the electrons and atoms only need be considered. The collision term in the Boltzmann equation is treated in two different ways. The first treatment employs "age theory." The second is a straightforward integration of the collision integral, employing both the properties of a generalized binary collision and the interaction cross section. This integration is made possible with the use of a delta function to pick out the allowed values of the electron velocity before the collision. The Boltzmann equation is expanded in spherical harmonics and the expansion is truncated after two terms. The resulting equations are solved by the procedure of taking moments over all speed. The various moment equations are then truncated eventually giving the final solutions. This analysis makes it possible to demonstrate two methods for increasing the electrical conductivity of a gas. The first shows that the conductivity can be enhanced when the electron source is given certain spectra. This can be accomplished by injecting electrons into the system with such spectra. A study is also made of the electron temperature of the gas because a rise in the electron temperature will increase the degree of ionization of the gas which increases the conductivity. The electron temperature is studied as a function of the applied electric and magnetic fields. It is shown that these methods can be used to increase the electrical conductivity of gases used in magnetohydrodynamic work. (Disser. Abstr.)

41889 THEORETICAL INVESTIGATION OF MAGNETOHYDRODYNAMIC TURBULENCE. Thomas, John Howard. Lafayette, Ind., Purdue Univ., 1966. 117p.

Thesis.

The theory of turbulence in an incompressible, viscous, electrically conducting fluid is formulated probabilistically through the use of the joint characteristic functional and the functional calculus. Dynamical equations and conditions for the joint characteristic functional are derived from the equations of magnetohydrodynamics. Dynamical equations for various order space–time correlations between velocity and magnetic field components are derived by expanding the joint characteristic functional in a functional Taylor series. Closure methods for this system of equations are discussed. The entire formulation is transformed to wavenumber space and new equations governing the joint characteristic functional are derived. Solutions for the joint characteristic functional are obtained for the special cases of stationary turbulence in an inviscid fluid with infinite electrical conductivity and turbulence in the final stages of decay. Equations for the kinetic and magnetic energy spectrum tensors are derived by again expanding the joint characteristic functional in a functional Taylor series. Equations for the scalar kinetic and magnetic energy spectrum functions are derived in the case of isotropic turbulence. Conservation laws are derived for the energy transfer functions appearing in these equations. The concepts of Kolmogorov's equilibrium hypothesis are extended to magnetohydrodynamic turbulence. After some criticism of previous works, forms for the energy transfer functions in the equilibrium range, based on Heisenberg's theory, are hypothesized. Using these forms, the spectrum equations are found to have solutions corresponding to equipartition of energy between the kinetic and magnetic spectra in the equilibrium range, and the spectra have the Heisenberg universal form. (Disser. Abstr.)

Geophysics

41890 (AD–645940) DERIVATIONS OF GEOMAGNETIC SHELL EQUATIONS. Report for February 1960–March 1961. Pennington, Ralph H. (Air Force Weapons Lab., Kirtland AFB, N. Mex.). Jan. 1967. 35p. (AFWL–TR–66–152). CFSTI.

A set of formulas was derived relating to charged particle shells in a geomagnetic field represented by a dipole and distortions of small magnitude. Recent interest in the use of computer codes in solving problems of trapped radiation in space has emphasized the need for publishing such formula derivations. (auth) (TAB)

41891 (AD–645954) MAGNETOHYDRODYNAMICS OF THE EARTH'S MAGNETIC FIELD. Technical Report No. 85-37. Venezian, Giulio (California Inst. of Tech., Pasadena. Div. of Engineering and Applied Science). Jan. 1967. Contract N0014-67-0094-0009. 31p. CFSTI.

A survey of observational and theoretical work pertaining to the origin of planetary magnetic fields is given with special emphasis on the dynamo theory which attempts to explain these fields as arising from magnetohydrodynamic regenerative action. Some points are raised regarding what a satisfactory theory should contain. It is suggested that reversals may occur without a drastic change in the internal flow. A method of using one model of dynamo action to obtain information about the structure of the flow in the core of the earth is proposed. (TAB)

41892 (AD–647690) A SUBSONIC D-REGION PROBE EXPERIMENT USING AN ULTRAVIOLET SOURCE TO PRODUCE IONS AND FREE ELECTRONS. Report No. Scientific-286. Gee, E. L. (Pennsylvania State Univ., University Park. Ionosphere Research Lab.). Dec. 20, 1966. Contract AF19(628)-4014. 55p. (AFCRL–67–0050). CFSTI.

An ultraviolet source for use in a lower D-region probe experiment was constructed. The use of this source with an ion collector probe designed by Hale and Hoult is described. It is felt that a lower limit on the order of 107 NO molecules per cm^3 could be detected with this experiment. (auth) (TAB)

41893 (AD–648719) ANALYSIS OF DATA RETURNED BY THE FESS EXPERIMENT FROM THE OV1-2 SPACE-CRAFT, PHASE I. Technical Report, October 1965–August 1966. Chapman, M. C. (Northrop Space Labs., Hawthorne, Calif.). Mar. 1967. Contract AF29(601)-7038. 110p. (AFWL–TR–66–94). CFSTI.

Automatic data processing techniques developed for reduction of data returned by the Flight Experiment Shielding Satellite (FESS) experiment from the OV 1-2 spacecraft are presented. Computer programs are discussed which accept data from digital magnetic tapes, remove instrument calibrations and temperature effects, organize and list the data, and electronically plot selected parameters. Experiment performance is reviewed; all instruments have operated in excess of nine months in orbit. Proton and electron spectrums are presented, and significant differences from the

Vette grids are found for some regions of space. Results of theoretical dose calculations using Vette grids and experimental FESS particle data are presented, and are compared with measured doses in the spacecraft, and influencing factors are discussed. Unidirectional flux grids in B, L space for typical L shells are presented. General recommendations are presented for further analyses of the data, taking into consideration the generally poor quality of the digital data tapes available for processing. (auth)

41894 (AD-648909) ON THE EXTRATERRESTRIAL RING CURRENT DURING GEOMAGNETIC STORMS. Progress Report, Report No. 67-9. Frank, L. A. (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). Feb. 1967. Contracts Nonr-1509(06); NAS5-2054. 65p. CFSTI.

Measurements of the differential energy spectrums of protons and electrons, separately, over the energy range extending from ≈200 eV to 50 keV with a sensitive array of electrostatic analyzers borne on the earth-satellite OGO 3 reveal large temporal variations in intensities of these low-energy charged particles at low and moderate latitudes in the outer radiation zone during two moderate geomagnetic storms in late June and early July 1966. The total energy of these low-energy protons and electrons within the earth's magnetosphere is sufficient to account for the depression of the geomagnetic field observed at the earth's surface over low and moderate latitudes; hence these charged particles may be identified as the major contributors to the storm-time extraterrestrial ring current. The apparent mean lifetimes of low-energy protons in the outer radiation zone are in agreement with calculated lifetimes assuming charge-exchange collisions with the ambient neutral and charged constituents of the terrestrial exosphere as the predominant loss mechanism. (auth) (TAB)

41895 (AD-649139) OBSERVATIONS OF INNER AND OUTER ZONE ELECTRONS SINCE DECEMBER 1965. Ryan, J. L.; Sferrino, V. J. (Massachusetts Inst. of Tech., Lexington. Lincoln Lab.). Dec. 28, 1966. Contract AF19(628)-5167. 20p. (ESD-TR-66-603). CFSTI.

A silicon surface-barrier detector electron telescope measuring integral and differential electron energy spectra over the range of 130 keV to 4.5 MeV was placed into orbit in late 1965. The initial orbit had an inclination of 26.6 degrees, apogee of 33,600 km, perigee of 200 km, and a mean orbital period of 589.6 minutes. The data from the experiment are presented in terms of single orbit passes on selected days showing outer zone maxima in omnidirectional flux intensity for 130 keV, 700 keV, and 2.5 MeV integral spectra in the region near L = 4, and a minimum near L = 3.5 which characterizes the slot between the inner and outer zones. Diurnal variations are characterized by flux changes which show marked correlation with K_p index at L = 6. The degree of correlation decreases with decreasing L value. Spectral steepening is seen to occur during periods of increased geomagnetic activity. The diurnal flux changes also exhibit energy vs time dependencies with the higher energy electron fluxes generally reaching their maximum later in time. (auth) (TAB)

41896 (AD-649541) ABSORPTION OF MICROWAVE RADIATION IN A SLIGHTLY-IONIZED GAS. Report No. 07599-10-T. Wald, L. H. (Michigan Univ., Ann Arbor. Dept. of Nuclear Engineering). Dec. 1966. Contract DA-31-124-ARO(D)-403. 154p. (AROD-6092:8).

Thesis.

The absorption of microwave radiation in a slightly ionized gas as a functoin of electron density was investigated. The data were provided by measurement of the absorption produced in a collimated 12-GHz microwave beam passing along the axis of a pyrex cylinder containing ionized helium. The absorption was found to be due partially to refractive-defocussing effects, but it was possible to measure and thus correct for these effects by use of a combination of the steady-state and afterglow absorption data. The corrected absorption data obtained were used to calculate collision frequencies which were then corrected for electron temperature changes and displayed as functions of both electron density and helium pressure. The collision frequencies were found to be independent of pressure to within probable error. (TAB)

41897 (CU-EE-100) STUDIES OF GUIDED ELECTROMAGNETIC WAVES IN THE PRESENCE OF AXIALLY NONUNIFORM OR RANDOM PERTURBATIONS. Scientific Report No. 3. Richter, Stephen L. (Columbia Univ., New York. Dept. of Electrical Engineering). Mar. 1967. Contract AF19(628)-5832. 197p. (AFCRL-67-0298). CFSTI.

A perturbation technique to deal with gross nonuniformities in an otherwise axially uniform waveguiding structure is presented and applied to time-harmonic electromagnetic propagation in the presence of not necessarily small perturbations which may have both axial and transverse dependence and may be either deterministic or random. The method, an iterative procedure similar to the Brillouin–Wigner approach for uniform perturbations, circumvents expansions in powers of a perturbation parameter, which is one cause of poor convergence for perturbations not sufficiently small. As in standard analyses for small perturbations, an expansion in normal modes is utilized, but with the inclusion of a nonlinear phase progression term in the exponent of the axial dependence of the incident mode. This normal mode expansion permits the calculation of the desired field quantities and, for the stochastic case, all the statistics of the field from the formal perturbation expressions for the modal amplitudes and phase progression, and effects of mode coupling or multiple scattering, and polarization effects due to the vector character of the electromagnetic fields, are thereby included in the formalism. Effects of phase changes introduced by the perturbation are explicitly included for all modes through the special iterative procedure and through the presence of the phase progression term. (auth)

41898 CHARACTERISTICS OF RADIOELECTRIC WHISTLERS AT LOW LATITUDES DURING THE IGY AND IQSY. Kimpara, Atsushi. Ann. Geophys., 23: 13-16(Jan.-Mar. 1967). (In French).

The frequency and dispersion of whistlers during IGY and IQSY, periods of maximum and minimum solar activity respectively, were studied, especially as regards their diurnal and annual variations. From July 1, 1957, to November 15, 1962, observations were made at Wakkanai (geographic coordinates 45°24′N, 141°41′E; geomagnetic coordinates +35.3°, 206.0°) and from November 16, 1962, at Moshiri (44°22′N, 142°16′E; +34.0°, 206.4°). Characteristics of the whistlers changed gradually, in relation to the decrease in solar activity. Study of the annual variations showed a maximum in February during IGY and IQSY, but a minimum in June during IGY and in July or August during IQSY. The diurnal variation was generally very irregular and no clear tendency was noted. In February when activity was strong, 2 maxima in the nighttime were noted, one 2 to 3 hr before sunrise and the other 2 to 3 hr after sunset. Extremely low dispersions were observed during IQSY, in general, much lower than in IGY. (BBB)

41899 MAGNETIC FIELD-ALIGNED IONIZATION LAYERS OBSERVED BY FARADAY ROTATION OF SATELLITE SIGNALS. Mass, Jonathan; Houminer, Zvi (National Committee for Space Research, Haifa, Israel). J. Geophys. Res., 72: 4940-4 (Oct. 1, 1967).

An abnormally strong change in the Faraday rate of the 40- and 41-Mc signals was observed on 3 revolutions of the S-66 satellite. Recordings of two of the revolutions are shown and indicate that the Faraday rate is first increasing and then slowly decreasing until a minimum is reached when the subsatellite point is at 7°N. The minimum in the Faraday rate is well defined and is probably caused by a large-scale reduction in electron concentration. Consideration is given to the use of Faraday fading data for determining electron content reduction in the irregularities. (J.H.M.)

41900 INTERPRETATION OF THE SUBSIDIARY PEAKS AT PERIODS NEAR 27 DAYS IN POWER SPECTRA OF GEOMAGNETIC DISTURBANCE INDICES. Shapiro, Ralph (Air Force Cambridge Research Labs., Bedford, Mass.). J. Geophys. Res., 72: 4945-9(Oct. 1, 1967).

It was shown by Shapiro and Ward [1966] that the 27-day variation of geomagnetic disturbance indices possesses two prominent side lobes: one at about 29.4 days and the other at about 26.0 days. Coleman and Smith [1966] claimed that the side lobes are produced by an annual amplitude modulation of the 27-day variation. Coleman and Smith did not show that such an annual amplitude modulation was taking place nor did they consider the amount of modulation that might be necessary to produce side lobes as large as those observed in the C_l spectrum. An effort is made to determine whether the 27-day variation of C_l was undergoing a sufficiently large annual amplitude modulation to produce peaks as large as the side lobes observed in the C_l spectrum. (J.H.M.)

41901 THE GEOMAGNETIC STORM OF APRIL 17–18, 1965. Meng, C.-I.; Akasofu, S.-I. (Univ. of Alaska, College). J. Geophys. Res., 72: 4905-16(Oct. 1, 1967).

The growth and decay of the geomagnetic storm of April 17–18, 1965, are studied by using records collected from 88 stations. In particular, the asymmetric growth of the main phase decrease is studied in detail. Results from simultaneous satellite observations are also discussed. (auth)

41902 ROCKET MEASUREMENT OF MIDLATITUDE NIGHT AIRGLOW EMISSIONS. Baker, Doran J.; Waddoups, Ray O. (Utah State Univ., Logan). J. Geophys. Res., 72: 4881-3 (Oct. 1, 1967).

Midlatitude altitude profiles of night airglow from the OH

(8, 3) band, the 5577 A OI line, and the continuum at 5775 A are reported. The profiles were obtained from rocketborne radiometers flown into the regions of interest. The maximum emission occurred at about 102 km for the OI line, 91 km for the continuum, and 97 km for the hydroxyl band. (auth)

41903 NEW INTERPRETATION OF LONG PERIOD MICROPULSATIONS. Swift, Daniel W. (Univ. of Alaska, College). J. Geophys. Res., 72: 4885-98(Oct. 1, 1967).

A new theory is proposed to account for certain types of long-period micropulsations. An instability associated with a field-aligned column of hot plasma is demonstrated; the energy of the oscillations results from the free energy associated with the inhomogeneous plasma. A dispersion relation is derived that has the complex frequency as an eigenvalue. The dispersion relation indicates that there are only a finite number of allowed frequencies and growth rates and these are consistent with observed micropulsation frequencies. The principal shortcoming is that the theory calls for a transverse scale size of the field-aligned column that is about a factor of 10 smaller than indicated by observation. If the requirement for small scale size can be overcome, the theory can account for the observed micropulsation characteristics. (auth)

41904 HYDROMAGNETIC TOROIDAL RESONANCE. Radoski, Henry R. (Boston Coll., Weston, Mass.); McClay, John F. J. Geophys. Res., 72: 4899-4903(Oct. 1, 1967).

The usual solution for the toroidal mode, predicting spatially dependent eigenfrequencies, is shown to be inconsistent. A reinterpretation of this solution, in which the frequency is a constant, violates the magnetohydrodynamic approximation in that it results in an infinite parallel current density. A possible modification of the toroidal equation by introducing an electric field parallel to the ambient magnetic field yields constant eigenvalues that depend on the dimensions of the resonant cavity rather than on the length of individual field lines. The geophysical implications of these results are discussed. (auth)

41905 SPORADIC E AS AN INDICATOR OF WIND STRUCTURE IN THE LOWER IONOSPHERE AND THE INFLUX OF METEORS. Wright, J. W. (Inst. for Telecommunication Sciences and Aeronomy, Boulder, Colo.). J. Geophys. Res., 72: 4821-9(Oct. 1, 1967).

Standard measurements of sporadic E blanketing frequencies (f_bE_s, assumed to indicate peak ion densities) during November 1965 from three temperate latitude stations are examined in the light of current theory that predicts two important properties of this variety of sporadic E: (a) that major events consist predominantly of slowly recombining monatomic ions, probably of meteoric origin, and (b) that these ions converge and accumulate in thin layers through combined effects of the geomagnetic field and the profile of horizontal winds. Two such levels of convergence seem to be indicated by daytime f_bE_s data. The hypothesis of a meteoric origin for the ions suggests that major events of f_bE_s might correlate with the increased meteoric mass arriving during large showers, as shown by radar meteor data. Some evidence of this correlation is shown during the November 1965 Leonid meteor shower. (auth)

41906 SIMULTANEOUS MEASUREMENTS OF AN INCIDENT HYDROGEN FLUX AND THE RESULTING HYDROGEN BALMER ALPHA EMISSION IN AN AURORAL HYDROGEN ARC. Romick, G. J.; Sharp, R. D. (Lockheed Palo Alto Research Lab., Calif.). J. Geophys. Res., 72: 4791-4801(Oct. 1, 1967).

Observations from a polar orbiting satellite and a ground-based station at College, Alaska, have provided simultaneous measurements of the incident proton-neutral hydrogen flux and the hydrogen Balmer alpha optical emission. The data were obtained during the initial quiet phase of an auroral disturbance and are representative of the quiet hydrogen arc. The bulk of the emission occurs near 115 km with a 25-km vertical extent and a latitudinal extent greater than 150 km. This picture is consistent with theoretical estimates on the depth of penetration of such particles with an exponential spectrum ($e^{-E/16\ keV}$) as was measured and indicates that most of the observed hydrogen Balmer emission is produced by protons in the energy range 3 to 40 keV with a maximum production efficiency in this case near 20 keV. The observation data yield a higher luminous efficiency than is predicted by existing theoretical treatments. An analysis of this discrepancy is consistent with the conclusion that collision excitations of the energetic neutral hydrogen atom dominate charge-exchange excitations in the production of the hydrogen Balmer emissions in the auroral hydrogen arc. (auth)

41907 MAGNETIC NOISE IN THE MAGNETOSHEATH IN THE FREQUENCY RANGE 3 TO 300 Hz. Smith, Edward J. (California Inst. of Tech., Pasadena). J. Geophys. Res., 72: 4803-13(Oct. 1, 1967).

Preliminary results are presented concerning rapid magnetic field variations (3 to 300 Hz) observed in the magnetosheath by the OGO 1 search coil magnetometer spectrum analyzer. Broadband signals are continuously present in the magnetosheath at these frequencies that are relatively intense and highly variable on a time scale of tens of seconds. Power spectral density estimates for several representative intervals lead to $B(f) \cong 1/f^3$ $(\gamma)^2\ Hz^{-1}$. This result extends previous estimates for the fluctuating magnetic fields in the magnetosheath up to 300 Hz and reveals an apparent change in the frequency dependence of the spectrum somewhere between 0.1 and 1 Hz. The observations are discussed in terms of the two transverse modes of plasma wave propagation that exist at frequencies below the electron gyrofrequency. Arguments are presented suggesting that some high-frequency bursts seen in interplanetary space just outside the bow shock are actually precursor waves propagating upstream against the solar wind. (auth)

41908 CORRELATION OF RESULTS OF SIMULTANEOUS MEASUREMENTS OF THE SOLAR WIND ON THE COSMIC SATELLITES VENERA-3 AND PIONEER-6. Gringauz, K. I.; Bezrukikh, V. V.; Musatov, L. S.; Solomatina, E. K. Kosm. Issled. Akad. Nauk SSSR, 5: 310-11(Mar.-Apr. 1967). (In Russian).

Measurements on Pioneer-6 were carried out from Dec. 18, 1965, to Dec. 31, 1965, by charged particle traps (Faraday cages) and by four spherical electrostatic analyzers. The average ion concentration and energy spectra were determined. In view of the fact that the distance between the two space probes was about 10^7 km, the agreement between the two sets of results on the variations in ion concentration can be considered as satisfactory. The similarity in the two sets of energy spectra is obvious in spite of a seven-hour time difference between the two spectra. The second peak on the energy spectrum, which is thought to be due to the presence of helium nuclei, was observed a number of times on Venus-3. As a whole a comparison of the two sets of results shows satisfactory agreement. (TTT)

41909 HEATING OF ELECTRONS IN THE DIURNAL IONOSPHERE. Petit, Michel (CNET, Hauts-de-Seine, France). Compt. Rend., Ser. A and B, 264: 1530-2(May 29, 1967). (In French).

The Thomson diffusion ionospheric probe makes it possible to measure systematically the variations of the electron and ion temperatures and the variations of the electron density as a function of the altitude between 110 and 500 km. The quantity of heat transferred to the electrons in order to compensate for the energy losses occurring during electron–ion collisions and electron–neutral particle collisions was deduced from the experimental results. The conductivity of the electron gas was also considered. The comparison with the theoretical predictions shows certain disagreements. (tr-auth)

41910 ROCKET MEASUREMENT OF THE IONOSPHERIC PLASMA BY GYRO-PLASMA PROBE. Oya, Hiroshi; Obayashi, Tatsuzo (Kyoto Univ.). Rep. Ionosphere Space Res. Jap., 21: 1-8 (1967).

A rocket-borne gyro-plasma probe, which employs the swept-frequency impedance probe technique, has been developed. An admittance of the probe immersed in the plasma is measured in a vector form (amplitude and phase) over a frequency range from 200 kc to 16 Mc, in which various plasma resonance effects are included. The experiment was performed using the L-3 H-2 rocket, on July 23, 1966. The electron density profile over the altitude range from 220 km was deduced from the measured upper hybrid resonance frequency within an error ±3%. The wake effect due to rocket motion, viz., a reduction in electron density, was also detected. The effect indicating a strong collisionless power dissipation was revealed from the analysis of the Q value of the upper hybrid resonance. (auth)

41911 RECOMBINATION COEFFICIENT OF THE UPPER-E AND F1 REGIONS DEDUCED FROM THE ELECTRON DENSITY PROFILE AT SUNSET MEASURED BY ROCKET BORNE GYRO-PLASMA PROBE. Oya, Hiroshi; Obayashi, Tatsuzo (Kyoto Univ.). Rep. Ionosphere Space Res. Jap., 21: 9-16(1967).

The effective recombination coefficient of the ionosphere in the altitude range of 130 to 180 km was deduced from the direct rocket measurement of the electron density at sunset by gyro-plasma probe. The recombination coefficient is estimated, using the data obtained in the shadow region of solar XUV, where the effects of the electron production due to photo-ionization and of the diffusion are fairly negligible. It was shown that the deduced recombination coefficient is an average value of 3.4×10^{-6} cm^3/sec. This value is larger, by an order of magnitude, than the previous experimental results obtained from the time variation of f_0F1, but is in agreement with the value estimated using the data of laboratory experiment. (auth)

41912 IONOSPHERIC CURRENT SYSTEM PRODUCED BY AN EXTERNAL ELECTRIC FIELD IN THE POLAR CAP. Iwasaki, N.; Nishida, A. (Tokyo Univ.). Rep. Ionosphere Space Res. Jap., 21: 17-28(1967).

The electric current distribution in the ionosphere with anisotropic conductivity is calculated, when an external electric field is applied, that is associated with a sinusoidal distribution of space charges along the circle of latitude 75°. The intensity and direction of electric current flow in high latitudes depend on the ionospheric conductivity values in the polar cap, auroral zone, and middle latitudes. The present model seems to explain some of the observed characteristics of S_q^p field and other current systems of polar cap origin, especially in their seasonal and local-time dependence. The shift of the current direction over the pole during the initial phase of magnetic storms will be explained by the enhancement of ionospheric conductivity in high latitude. (auth)

41913 PROTON DENSITIES IN THE MAGNETOSPHERE FROM PEARL DISPERSION MEASUREMENTS. Liemohn, H. B.; Kenney, J. F.; Knaflich, H. B. (Boeing Scientific Research Labs., Seattle). Earth Planet. Sci. Lett., 2: 360-6(July 1967).

The dispersion characteristics of 75 Pc 1 micropulsation pearls are described and analyzed. The results show that these emissions are generated on field lines with equatorial intercepts between four and nine earth radii. There is a diurnal variation in the location of the propagation paths which constitute a pearl oval with nighttime pearls propagating closer to the earth at higher frequencies than daytime pearls. This pearl oval expands to lower latitudes with an increase in the bulk velocity of the solar wind. The exospheric plasma densities derived from this research are in reasonable agreement with previous ulf and vlf results, but it appears that pearls are generated primarily on very steep density gradients that may coincide with the plasmapause already detected by vlf whistlers. (auth)

41914 STUDIES ON THE EFFECTS OF THE INTERPLANETARY SPACE ENVIRONMENT ON THERMAL-CONTROL COATINGS. Breuch, R. A. (Lockheed Missiles and Space Co., Palo Alto, Calif.). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 5: 1650-4(Sept. 1967).

The interplanetary space environment is reviewed and its effects on surface thermal radiative properties postulated. Laboratory data on the effects of the important constituents of the interplanetary environment are presented. These data include the results of exposures of materials to simulated quiescent solar plasma, solar ultraviolet, and simultaneous solar wind-plus-ultraviolet environments. The data indicate that the maximum change in solar absorptance under combined environment exposure will be no more than the maximum value of solar absorptance incurred under the most damaging singular environment, major synergistic effects being not important at the maximum integrated exposures reported herein (8×10^{15} hydrogen/cm^2 at 2000 ev plus ~300 sunhours 0.2 to 0.4 μ radiation). Data also indicate that solar wind studies must be performed with particles of solar wind energy. The combined environments chamber and the limitations of the test data are discussed. (auth)

41915 AUTOMATIC MEASUREMENT OF VARIATIONS IN THE FREQUENCY OF RESONANCES OF THE EARTH-IONOSPHERE CAVITY. Benoit, Clara; Etcheto, Jean; Gendrin, Roger. Ann. Geophys., 23: 132-5(Jan.-Mar. 1967). (In French).

A description is given of an apparatus for analyzing the frequency variations of earth-ionosphere cavity modes. Since the earth-ionosphere cavity presents a low Q and because of the statistical fluctuations of the signal, the frequency resolution depends closely on the integration time. It is shown that in order to obtain a good resolution (~0.1 Hz) it is necessary to integrate during a period of about 1 hr. Examples of frequency diurnal variation are given, which are in good agreement with the theorical results predicted by Madden and Thompson. Verification of the satisfactory functioning of the apparatus was achieved by analyzing the records obtained in July 9, 1962, which correspond to a high-altitude nuclear explosion (Operation Starfish). Comparison of the data obtained here with that of Gendrin and Stewart and of Balser and Wagner for the same period showed the much lower dispersion of points achieved with the new apparatus. (BBB)

41916 CORRELATIONS AMONG NIGHT AIRGLOW RADIATIONS. Kulkarni, P. V.; Steiger, W. R. (Univ. of Hawaii, Honolulu). Ann. Geophys., 23: 125-31(Jan.-Mar. 1967).

From extensive data collected over a period of 2 yr at Haleakala (Maui, Hawaii), long-term correlations between night airglow radiations at 6300, 5893, and 5577 Å were calculated. Total night sky radiation around 5300 Å included the terrestrial (airglow continuum) and the extraterrestrial (zodiacal light and starlight) components. From the total radiation observed around 5300 Å, for every individual observation, the extraterrestrial component was eliminated to get the airglow continuum. Its correlation with the above-mentioned line emission was also calculated. The results from this study are discussed and compared with earlier ones. (BBB)

41917 ON THE USE OF A TECHNIQUE FOR COMPENSATION IN THE EVALUATION OF IONOSPHERE DRIFT MEASUREMENTS. Zschau, G. (Observatorium, Geophysikalisches Institut, Oschatz, Ger.). Wiss. Z. Karl-Marx-Univ., Leipzig, Math.-Naturwiss. Reihe, 14: 745-7(1965). (In German).

Improved delineation of the "characteristic ellipse" for the determination of ionospheric drift is demonstrated. Improved results are obtained by choosing n points to construct $\binom{n}{3}$ triangles, so that each triangle supports the separate determinations of three ellipse circumferential points. Since, in general, the points do not fit the equation of an ellipse, a mean ellipse is constructed so that squares of deviations from the circumference is a minimum. The theoretical foundations of the compensation technique for finding the least-squares ellipse and a practical example of its use are given. (BBB)

41918 IONOSPHERIC STUDIES BY THE SATELLITE ARIEL. Boyd, R. L. F. (Univ. Coll., London). Denki Gakkai Zasshi, 9: 289-91(July 1963).

Satellite experiments were aimed at measuring the concentration and temperature of the ionospheric electrons and the spectra of the solar x radiation that is responsible for ionization in the E and D regions. Data were also obtained on the mass spectrum and temperature of the positive ions. The spectrometer on Ariel employed (for the first time on a satellite) a system of proportional counters and pulse-height analysis. Several spectra of flares were obtained. A typical case for a Class 1 or 1-flare, together with spectra obtained before and after, is shown. The nonflare spectrum fell rapidly with decreasing wavelength and was no longer measurable below 6Å. The nonflare spectrum indicated a fluctuation of total intensity below 13 Å by as much as 75% in a half hour. Spectra obtained during several flares showed the solar emission to be intensified with significant hardening of the spectrum. Electron concentration data obtained enabled a comprehensive account of the ionization in the altitude range 400 to 1200 km and the latitude range +54° to −54°. There was an indication of magnetic control of the distribution of ionization above the F-region maximum and evidence from the distribution for a significant contribution to the ion balance from corpuscular radiation. Electron temperature data revealed that the temperatures from midnight over the equator to midday at latitude 54° varied from near 600 to about 2200°K. The ion mass spectrum data indicated the existence of layers in which O^+, He^+, and H^+ progressively become the dominant ion as altitude increases, the changes occurring around 600 and 1200 km at night and about 950 and beyond 1200 km (the apogee high) during the day. (BBB)

41919 NEW AUTOMATIC RECORDER FOR IONOSPHERIC DRIFT MEASUREMENTS. Koch, H.; Schminder, R.; Kuerschner, D. (Karl-Marx-Univ., Leipzig). Z. Geophys., 28: 281-8(1962). (In German).

A recorder for ionospheric drift measurements made according to Krautkraemer's method is described, which allows direct reading of the time differences between corresponding extremes in the signal voltage curves. The apparatus offers economy in operation and in evaluation of measurements and permits of making continuous registrations. Comparative measurements using conventional techniques showed that, in spite of some inherent limitations, the apparatus is capable of yielding sufficiently accurate mean values of drift velocity and drift direction. Some data recorded with the instrument described are presented and interpreted. (BBB)

41920 INVESTIGATION OF THE DISPERSION OF THE NORMAL DAILY VARIATION OF THE CRITICAL FREQUENCY OF THE IONOSPHERIC F2 LAYER. Singler, Anton (Heinrich-Hertz-Institut, Adlershof, Ger.). Beitr. Geophys., 74: 357-65 (1965). (In German).

For radio propagation forecasts it is important to know the features of the irregular changes in the daily increase and decrease of ionization in the F2 layer. The range of dispersion of critical frequencies can be determined by expanding diurnal variations in a Fourier series dependent on the season and on solar activity. The range of dispersion shows a weak dependence on the season and is related to the sunspot number by a quadratic equation. Data for central Europe during the years 1951 to 1957 are correlated graphically. The maximum in the range of dispersion is suggested to be a saturation effect based on the relative insensitivity of the relatively highly ionized F2 layer to irregular solar and terrestrial influences during periods of maximum solar activity. (BBB)

41921 ON THE VARIATION OF THE NIGHTTIME VALUE OF COSMIC NOISE MEASUREMENTS AT 24.95 MHz. Ohle, K. H.

(Heinrich-Hertz-Institut fuer Schwingungsforschung, Neustrelitz, Ger.). Beitr. Geophys., 76: 5-10(1967). (In German).

The cosmic noise method can be used for determination of absorption in the ionosphere in the frequency range from 15 to 60 Mc. Extraterrestrial radiofrequency radiation was measured at Neustrelitz (ϕ = 53°17' N, λ = 13°95' E) in 1963. A time variation of the nighttime values of cosmic noise intensity at 25 Mc was found. The nighttime intensity values N_θ increased with decreasing solar activity. The computation of the final ionospheric absorption values from cosmic noise measurements must be based on the nighttime intensities N_θ at the minimum of solar activity. Some problems introduced into the cosmic noise method for measurements of ionospheric absorption because of the observed variations in the nighttime value with solar activity are discussed. (BBB)

41922 ON THE CONNECTION OF METEOR ACTIVITY WITH THE OCCURRENCE OF THE SPORADIC E LAYER. Triskova, L. (Geophysical Inst., Prague); Samardjiev, D. Beitr. Geophys., 76: 1-4(1967).

Results of measurements on a 1100-km long vhf forward scatter path are given for the period from April 1963, to December 1965, showing a correlation of nighttime and winter E_S layer of longer duration with extremely active meteor showers. A close correlation of sporadic E layer with a meteor shower was demonstrated for the November Leonid shower, as shown by recordings on Nov. 17, 1964, and Nov. 17, 1965, between 04.00 and 07.20 local time (Central European Time). On the 1964 recording, reflections of several minutes duration were rare. In 1965, when great activity of the Leonid meteor shower was noted, the signal level was above 10 db, except for fadings. On the basis of these results it is suggested that a relation between the occurrence of sporadic E layer and meteor activity actually exists. Probably, it is not the meteoric ionization itself which is the determining influence, but the higher meteor activity likely creates more favorable conditions for the action of some factors of E_S layer formation. (BBB)

41923 EFFECT OF THE NONLOCAL HEATING OF THE DIURNAL IONOSPHERE ELECTRONS. Petit, Michel (Centre National d'Etude des Telecommunications, Issy-les-Moulineaux, France). Compt. Rend., Ser. A and B, 264: 1622-4(June 5, 1967). (In French).

Taking into account the displacement of the photoelectrons along the lines of force of the terrestrial magnetic field modifies appreciably the variation, as a function of the altitude, of the quantity of energy communicated to the electron gas. A much better agreement is attained with the measurements obtained by the Thomson diffusion probe. (tr-auth)

41924 THE LUNAR TIDE IN THE E-LAYER. Brown, R. A. (London Univ.). J. Atmos. Terrest. Phys., 29: 1087-93(Sept. 1967).

Regular readings of f_0E taken at Ibadan for 14 yr (from 1951 to 1965) were analyzed by an improved technique to determine the lunar tidal effect. This is shown to be small and to contain both diurnal and semidiurnal components. There is found to be a large seasonal variation of the tide and a regular variation of the tidal phase with the layer height. (auth)

41925 LOSS OF LOW-ENERGY POSITIVE IONS FROM THE INNER RADIATION ZONE. Allum, F. R.; O'Brien, B. J. (Rice Univ., Houston, Tex.). J. Atmos. Terrest. Phys., 29: 1071-85 (Sept. 1967).

A study was made of the loss by charge exchange of the large flux of low-energy positive ions trapped in the inner radiation zone and detected by two satellite-borne experiments. If these trapped particles are singly charged helium ions, their lifetime is calculated here to lie between 1.4×10^4 and 9×10^2 sec for particles with mirror points (L = 1.4, B_m = 0.12) and (L = 1.4, B_m = 0.21) respectively. If these trapped ions are protons, the lifetimes for the same (L, B_m) coordinates range between 600 and 200 sec. These calculated lifetimes are much less than the longitudinal drift period, and the resultant severe constraints on postulated source mechanisms are examined. The night-sky intensities of the 3914 Å N_2^+ and H_β emissions arising from a resulting proton influx are calculated for locations near the Rio minimum. For atmospheric conditions corresponding to S' = 50×10^{-22} W m^{-2} c/s^{-1} and local time T = 21.00 hr, the H_β intensity varies between 5 Rayleighs (5R) at longitude 310°E, latitude 25°S, and 75 R at longitude 325°E, latitude 30°S. For these same locations and atmospheric conditions, the intensity of the 3914 Å emission ranges from 100 R to 1.5 kR. A worldwide source strength of 5×10^{16} erg sec^{-1} or 10^{16} erg sec^{-1} is required to maintain a steady-state distribution of particles in the trapping regions if the experimental flux arises from protons or helium ions respectively. An injection mechanism involving neutral atoms from the solar wind is shown to be incapable of supplying energy at the required rate unless there are equal numbers of charged and neutral particles in the solar wind, a possibility deemed very unlikely. Other effects of such a trapped flux are treated briefly. (auth)

41926 A STUDY OF IONOSPHERIC PULSE ABSORPTION (A1) ON 4 Mc/s DURING THE SOLAR ECLIPSE OF MAY 20, 1966. Bischoff, K.; Taubenheim, J. (Heinrich-Hertz-Inst., Berlin). J. Atmos. Terrest. Phys., 29: 1063-9(Sept. 1967).

Results of ionospheric pulse absorption measurements (A1 method) on 3.86 Mc in southeast Bulgaria during the solar eclipse of May 20, 1966, can be quantitatively interpreted by a two-layer model, dividing the total absorption into a contribution from a parabolic E layer, calculated from simultaneous ionogram data, and a contribution from an idealized "thin" D layer, obeying an effective recombination law. Experimental indications of a possible non-uniform brightness distribution of the x-ray emission over the Sun's disc are discussed. In agreement with the results of an earlier study of the 1961 solar eclipse, the contributions of the E and D layers to total absorption are found to be nearly equal, confirming the recent models of electron density distribution and collision frequency profiles in the D and E regions. (auth)

41927 SCHUMANN RESONANCES AND elf PROPAGATION FOR INHOMOGENEOUS, ISOTROPIC IONOSPHERE PROFILES. Jones, D. Llanwyn (London Univ.). J. Atmos. Terrest. Phys., 29: 1037-44(Sept. 1967).

The results of calculations of Schumann resonance frequencies and Q factors and the propagation constant of the terrestrial waveguide at extremely low frequencies (elf) are reported. Calculations were made for ionosphere conductivity profiles derived by Pierce and Cole and by Deeks. The results are sensibly identical to those obtained using the simple two layer model derived previously by the author and as such are compatible with experimental data obtained from studies of Schumann resonance and atmospherics. (auth)

41928 DISTRIBUTION OF AMPLITUDE SCINTILLATION AND THE CONVERSION OF SCINTILLATION INDICES. Chytil, B. (Geophysical Inst., Prague). J. Atmos. Terrest. Phys., 29: 1175-7(Sept. 1967).

The relationship between the most commonly used measures of scintillation depth is deduced assuming that the probability density of amplitude distribution is Nakagami's m distribution. (auth)

41929 DIURNAL DISTRIBUTION OF SSCs OF DIFFERENT SIZES IN "H" IN THE ALIBAG MAGNETOGRAMS FOR THE PERIOD 1921–1960. Sastri, N. S.; Jayakar, R. W. (Colaba Observatory, Bombay). J. Atmos. Terrest. Phys., 29: 1165–7(Sept. 1967).

Diurnal distribution of frequency of occurrence at Alibag of SSCs of different sizes of the main impulse in "H" is examined and is found to depend to a large measure on their sizes. The distribution curves for size ranges $\leq$10 γ and 11 γ to 30 γ show a general resemblance to the S_q(H) curve at Alibag. (auth)

41930 AURORAL MOTIONS OBSERVED WITH RIOMETERS: MOVEMENTS BETWEEN STATIONS WIDELY SEPARATED IN LONGITUDE. Hargreaves, J. K. (Inst. for Telecommunication Sciences and Aeronomy, Boulder, Colo.). J. Atmos. Terrest. Phys., 29: 1159-64(Sept. 1967).

Auroral-zone riometers separated by over 80° of magnetic longitude show that features of the auroral radio absorption move eastward between 00.00 and 14.00 hr L.T. and westward between 14.00 and 24.00 L.T. The typical velocity is 4° of longitude/min, or 3.7 km/sec. A statistical study of the occurrence of reported absorption events leads to a similar, though not identical, pattern but indicates smaller velocities. In some examples the movement can be traced nearly half way around the auroral zone, and when the stations are suitably placed it is possible to observe both the eastward and westward movements simultaneously. It is concluded that the typical auroral disturbance propagates around the Earth, beginning near the midnight meridian. (auth)

41931 10.7-cm SOLAR RADIO FLUX AND IONOSPHERIC TEMPERATURES. Mahajan, K. K. (Arecibo Ionospheric Observatory, Puerto Rico). J. Atmos. Terrest. Phys., 29: 1153-8(Sept. 1967).

Electron and ion temperatures, derived from backscatter spectra, are examined during the current rising phase of solar activity. There is a strong positive correlation between the 10.7-cm solar radio flux and night-time ion and electron temperatures, the temperature increase being about 3.4°K for each unit increase of 1×10^{-22} W/m^2 per c/s bandwidth in $\overline{S}_{10.7}$, the 27-day average 10.7-cm solar flux. The noontime ion temperature at and below 400 km shows an equally strong correlation with the 10.7-cm flux, the temperature increase being about

4.5°K for each unit increase of $\overline{S}_{10.7}$. Any correlation of the noontime electron temperature, and the noontime ion temperature for heights above 400 km, with the 10.7-cm solar flux, if present, is masked by the more predominant effect associated with the wide day-to-day electron density variations. (auth)

41932 EXTENT OF THERMAL NONEQUILIBRIUM IN THE IONOSPHERE. Mahajan, K. K. (Arecibo Ionospheric Observatory, Puerto Rico). J. Atmos. Terrest. Phys., 29: 1137-51 (Sept. 1967).

The extent of thermal nonequilibrium in the ionosphere, during sunspot minimum, is examined using electron temperatures derived from ionosonde-backscatter comparisons and backscatter spectra. The ionosonde-backscatter comparisons are used to provide information below the F-layer peak, a region where no systematic results are available. The backscatter spectra are used to obtain electron temperatures above the F-layer peak (nominally 250 km) to heights of about 500 km. The studies indicate that the electron temperatures increase with height from 120 to 200 km and 300 to 500 km. In the interval from 200 to 300 km, the temperatures increase or decrease depending upon the electron density at these levels. The electron temperatures and their height gradients show a wide variation from one day to another, but are found to be closely related to the electron density variations. As such, any comparisons of electron temperatures obtained by different techniques, at the same or different locations, may not be conclusive if electron densities are not the same at these locations during the time of comparisons. (auth)

41933 POLAR MAGNETIC SUBSTORM IN THE EVENING SECTOR. Akasofu, S.-I.; Meng, C.-I. (Univ. of Alaska, College). J. Atmos. Terrest. Phys., 29: 1127-35(Sept. 1967).

The morphology of the disturbance field of the polar magnetic substorm in the evening sector is studied by using a chain of four Alaskan north–south stations distributed between dp lat 61 and 70°. It is shown that in the evening sector a typical auroral zone station is situated in a transition belt between the region of an intense negative bay on the poleward side and the region of a weak positive bay on the equatorward side and thus experiences a great variety of types of the disturbance field. The most common types of the disturbances are classified, and a typical latitudinal change of the disturbance between 70° and 60° is obtained. (auth)

41934 MAGNETIC PERTURBATIONS CAUSED BY NUCLEAR EXPLOSIONS. Laszlo, Sajti. Magy. Geofiz., 7: 168-70(1966). (In Hungarian).

In August and September 1958 (following the "Argus I, II, III" test explosions) and on July 9, 1963, after the nuclear explosions in upper atmosphere, perturbations appeared in the earth's magnetic field. The effect of the July 9, 1963, explosion in the Pacific Ocean on Johnston Island could be detected in Hungary. An analysis of the registrations of the observatory in Tihany is reported. (tr-auth)

41935 ABSORPTION OF VERY LOW FREQUENCY WAVES IN THE WHISTLER MODE OF PROPAGATION AT LOW LATITUDES. Somayajulu, V. V.; Tantry, B. A. P. (Banaras Hindu Univ., Varanasi, India). J. Geomagnet. Geoelec., 19: 81-9 (1967).

Absorption of very-low-frequency (vlf) waves in the whistler mode of propagation at low geomagnetic latitudes of 24° and 15° was calculated for various ionospheric conditions during sunspot maxima, average and minima. The very high absorption values of 60 dB, 46 dB, 22 dB at 24° and 104 dB, 90 dB, 42 dB at 15° of vlf waves (10 kc, 5 kc and 1 kc) for two ionospheric paths between 50 to 200 km height can explain the nonoccurrence of whistlers and vlf emissions such as chorus and hiss at low geomagnetic latitudes during day time. The absorption contributed by F region, though generally smaller than that contributed by D and E regions, is never negligible and at times of high F region concentrations during the magnetic storms the F region absorption may even be dominant. The absorption of vlf waves is low at night and as such can not explain the low occurrence of whistlers during night time. However, when the angle between the magnetic field and the wave normal is taken into account it is found that the absorption index increases considerably and hence the whistler energy may not be received on the ground especially at geomagnetic latitudes below 15°. Comparing the computed values of absorption of vlf waves by Altman and Cory at 40° geomagnetic latitude and Laschy at 55° latitude with our values, for low latitudes it is found that the absorption increases rapidly as the latitude decreases which is in conformity with the results of Helliwell and Altman and Cory. (auth)

41936 ROLE OF ELECTRIC FIELD GENERATED IN THE EQUATORIAL ELECTROJET REGION. Singh, R. N.; Misra, K. D. (Banaras Hindu Univ., Varanasi, India). J. Geomagnet. Geoelec., 19: 143-53(1967).

Adopting an atmospheric model for the sunspot maximum day, the height variations of various ionospheric conductivities have been computed. The electric currents are calculated from yearly averaged magnetic data for the sunspot maximum period in 1958. Using the height integrated Cowling conductivity, electric fields for five selected equatorial and nonequatorial stations have been obtained from the calculated electric currents. The electric currents and electric fields thus obtained were compared with the electric field derived from the rocket measured electrojet current density. It is shown that such comparisons give good overall agreement of the results obtained from magnetic data and the rocket measurements. The electron temperature is calculated from Joule heating considerations. The resulting electron temperature has been found to be smaller than the rocket measured values. The vertical electron drift velocity produced by the electric field in the electrojet region has been calculated and is found to be higher than the earlier calculation of Hirono and Kitamura (1956) and compares well with the drift velocity values obtained from continuity equation. (auth)

41937 IONOSPHERIC NO-ECHO OCCURRENCES. Bellchambers, W. H. (Radio and Space Research Station, Slough, Eng.). Nature, 215: 841-2(Aug. 19, 1967).

Use of ionogram data to identify periods of high absorption has been criticized. This criticism is justified at a number of stations, but does not apply to stations where adequate precautions are taken in the ionogram analysis. Every no-echo event at Halley Bay during the IGY and IQSY was scrutinized, taking into account background noise level, the value of critical frequency immediately before and after the "blackout," and any evidence for tilts which would be expected if the critical frequency had fallen during the "blackout" record. It is thought that not more than 1% of the total "blackouts" recorded could be challenged. The diurnal variation of the F2 layer critical frequency was examined on the days which showed no-echo conditions and compared with the corresponding variation for other days. The critical frequencies were somewhat higher than normal on the days with no-echo conditions. As an additional check, high sensitivity absorption equipment was used during many of the events. Despite the widely different critical frequencies in the IGY and IQSY, the "blackout" phenomena previously reported recurred, at a lower rate of occurrence but at essentially the same times as in the IGY, and showed the same relation to magnetic activity. Riometer measurements are compared with those using ionosonde or field strength measurements at lower frequencies. (UK)

41938 NATURAL ELECTROMAGNETIC PHENOMENA BELOW 30 KC/S. Proceedings of a NATO Advanced Study Institute Held in Bad Homburg, Germany, July 22–August 2, 1963. Bleil, D. F. New York, Plenum Press, 1964. 475p. $17.50. (CONF-630703).

Sixteen papers on various aspects of natural electromagnetic phenomena are presented. Separate abstracts were prepared for each paper. (J.H.M.)

For abstracts of individual papers see: 41300 and 41939–41953.

41939 ASPECTS OF THE STRUCTURE AND DYNAMICS OF THE TERRESTRIAL MAGNETOSPHERE. Axford, W. I. (Cornell Univ., Ithaca, N. Y.). pp 5-32 of Natural Electromagnetic Phenomena Below 30 kc/s. Bleil, D. F. (ed.). New York, Plenum Press, 1964.

From NATO Advanced Study Institute, Bad Homburg, Ger., July 22–Aug. 2, 1963. See CONF-630703.

Theoretical aspects and space probe observations of the shape of the magnetosphere are discussed. Consideration is given to motions in the magnetosphere, the relation of motion to the energization of charged particles, and disturbance phenomena in the outer magnetosphere, which include solar wind interactions. (J.H.M.)

41940 PENETRATION OF INTERPLANETARY PLASMA INTO THE MAGNETOSPHERE. Alfven, H.; Danielsson, L.; Falthammer, C-G.; Lindberg, L. (Royal Inst. of Tech., Stockholm). pp 33-48 of Natural Electromagnetic Phenomena Below 30 kc/s. Bleil, D. F. (ed.). New York, Plenum Press, 1964.

From NATO Advanced Study Institute, Bad Homburg, Ger., July 22–Aug. 2, 1963. See CONF-630703.

Theoretical and experimental evidence is presented to indicate that the usual magnetospheric models may need essential modification. Theoretically, it is concluded that the low-density magnetospheric plasma, in contrast to an ideal magnetofluid, may support strong electric fields even along the magnetic field lines. This can profoundly influence the penetration of interplanetary plasma. Laboratory experiments show that a plasma can penetrate much closer to a terrella than what would correspond to the magnetosphere boundary in closed magnetosphere models. (auth)

41941 GEOMAGNETIC STORMS. Sugiura, Masahisa (Goddard Space Flight Center Greenbelt, Md.). pp 49-75 of Natural Electromagnetic Phenomena Below 30 kc/s. Bleil, D. F. (ed.). New York, Plenum Press, 1964.

From NATO Advanced Study Institute, Bad Homburg, Ger., July 22–Aug. 2, 1963. See CONF-630703.

The different phases that a magnetic storm undergoes in the course of its development and decay are reviewed. Storm variations in the auroral zones are considered. (J.H.M.)

41942 AURORA. McNish, A. G. (National Bureau of Standards, Washington, D. C.). pp 77-93 of Natural Electromagnetic Phenomena Below 30 kc/s. Bleil, D. F. (ed.). New York, Plenum Press, 1964.

From NATO Advanced Study Institute, Bad Homburg, Ger., July 22–Aug. 2, 1963. See CONF-630703.

Various aspects of the aurora, which include geographical distribution, are reviewed. The discussions concentrate on the relation between auroral phenomena and other geophysical phenomena, in the fields of aeronomy and geomagnetism. (J.H.M.)

41943 IONOSPHERE: PROPAGATION THEORY. Gibbons, J. J. (Pennsylvania State Univ., University Park). pp 95-105 of Natural Electromagnetic Phenomena Below 30 kc/s. Bleil, D. F. (ed.). New York, Plenum Press, 1964.

From NATO Advanced Study Institute, Bad Homburg, Ger., July 22–Aug. 2, 1963. See CONF-630703.

Theoretical aspects of the propagation of electromagnetic signals through the ionosphere are discussed. Propagation equations are shown, and consideration is given to the influence of electron density on propagation. Information on propagation during a magnetic storm is included. (J.H.M.)

41944 EXPERIMENTAL RESULTS AND TENTATIVE EXPLANATIONS FOR GEOMAGNETIC EFFECTS CAUSED BY HIGH ALTITUDE NUCLEAR DETONATIONS. Seizer, E. (Institut de Physique du Globe, Paris). pp 107-42 of Natural Electromagnetic Phenomena Below 30 kc/s. Bleil, D. F. (ed.). New York, Plenum Press, 1964.

From NATO Advanced Study Institute, Bad Homburg, Ger., July 22–Aug. 2, 1963. See CONF-630703.

Magnetic perturbations caused by high-altitude nuclear detonations are discussed. Results from Starfish Burst, Argus Experiment, and two Russian tests (October 22, 1962, and October 28, 1962) are included. World distribution of the maximum magnetic horizontal perturbations from Starfish Burst is shown. (J.H.M.)

41945 OBSERVATIONS OF ENHANCHED RADIATION IN THE kc/s-BAND (5 AND 8 kc/s) DURING AURORAL AND GEOMAGNETIC DISTURBANCES. Harang, L.; Larsen, R. pp 143-56 of Natural Electromagnetic Phenomena Below 30 kc/s. Bleil, D. F. (ed.). New York, Plenum Press, 1964.

From NATO Advanced Study Institute, Bad Homburg, Ger., July 22–Aug. 2, 1963. See CONF-630703.

The appearance of enhanced vlf radiation on 8 kc (and also on 5 kc) was observed during auroral displays and geomagnetic storms. The flux of the bursts is of the order of 10^{-18} watt/m^{2}c. The appearance of the vlf bursts during various types of geomagnetic disturbances is discussed. The vlf bursts have their greatest amplitudes during the positive phase of the geomagnetic storm and often during only slight disturbances. During great, and negative, disturbances, when the auroral zone is displaced laterally toward south and strong absorption overhead appears indicated by the considerable riometer deflections, the vlf burst activity decreases. There is often a close parallel in appearances of quiet auroral arcs and bands appearing on the low northern horizon and strong vlf bursts, whereas strong auroral displays overhead may not be accompanied by intense vlf bursts. Simultaneous records on 5 and 8 kc show a closely parallel amplitude variation, but the relative magnitude of the amplitudes may change during the period of burst activity, indicating a change in the spectral composition of the bursts. Reception on E–W and N–S orientated frames shows that the mean "zero" level of hiss during undisturbed conditions is different. It is stronger from E–W than from N–S direction. Upon this directional "zero" level, the vlf bursts arrive with amplitudes of the same order of magnitude in both frames. The appearance of vlf radiation is normally confined to the night hours. In some cases, during strong geomagnetic disturbances, examples of "noise" storms lasting almost one whole day were recorded. (auth)

41946 ELF (500-1000 CPS) EMISSIONS AT HIGH LATITUDE. Egeland, Alv (Kiruna Geophysical Observatory, Sweden). pp 157-66 of Natural Electromagnetic Phenomena Below 30 kc/s. Bleil, D. F. (ed.). New York, Plenum Press, 1964.

From NATO Advanced Study Institute, Bad Homburg, Ger., July 22–Aug. 2, 1963. See CONF-630703.

Naturally, occurring electromagnetic radiation in the audio- and subaudio-frequency range has been studied in recent years at Kiruna Geophysical Observatory (geomagnetic latitude 65.3°N). Many emission bands, which are quite distinct from the normal background signals and are obtained as strong enhancements in portions of the spectrum, were recorded. The main results observed for the emissions between 500 and 1000 cps are: (1) the frequency of the maximum signal strength of the emission band is almost constant in time; e.g., at 650 cps ± 150 cps; (2) the amplitude of the emission at 650 cps is often ten times higher than the normal background noise level at this frequency range; (3) the average half-intensity bandwidths of these 650 cps emissions are ±200 cps; (4) a pronounced morning maximum (between 04 and 10 MET) is found for the different seasons; (5) the diurnal variation, as well as the correlation with micropulsations, indicate that the behavior of the 650 cps enhancements are different from all other audio-frequencies investigated at the Kiruna Observatory; (6) it seems likely that the 650 cps radiation is an auroral zone phenomenon; and (7) a marked Doppler broadening band shift is found for many of the emission events. It is considered probable that these emissions consist of electromagnetic radiation generated outside the E region by arrival of protons, which is propagated in the extraordinary mode along the lines of force of the earth's magnetic field. (auth)

41947 WHISTLER MODE AND THEORY OF VLF EMISSION. Gallet, R. M. (National Bureau of Standards, Boulder, Colo.). pp 167-204 of Natural Electromagnetic Phenomena Below 30 kc/s. Bleil, D. F. (ed.). New York, Plenum Press, 1964.

From NATO Advanced Study Institute, Bad Homburg, Ger., July 22–Aug. 2, 1963. See CONF-630703.

In discussing the theory of natural vlf emissions, it is assumed that: (1) the electromagnetic wave propagates in the whistler mode, and follows lines of force in the magnetosphere; and (2) the source of energy for the vlf emission is a stream, or discrete bunch of high-energy electrons following a line of force. Consideration is given to the frequencies which can be emitted at a given position in the magnetosphere and how the shape of the spectra of vlf emissions can be computed. (J.H.M.)

41948 TERRESTRIAL EXTREMELY-LOW-FREQUENCY PROPAGATION. Galejs, J. (Sylvania Electronic Systems, Waltham, Mass.). pp 205-60 of Natural Electromagnetic Phenomena Below 30 kc/s. Bleil, D. F. (ed.). New York, Plenum Press, 1964.

From NATO Advanced Study Institute, Bad Homburg, Ger., July 22–Aug. 2, 1963. See CONF-630703.

After a brief historical review of work on elf propagation and a summary of fundamental concepts, recent analytical and experimental results are reported. Data on propagation characteristics and noise spectra are described in a discussion on thunderstorm excitation. Several propagation models are discussed, and various field representations, the sharply bounded ionosphere, and isotropic and anisotropic inhomogeneous ionosphere models are considered. (J.H.M.)

41949 WHISTLERS AND VLF EMISSIONS. Katsufrakis, J. (Stanford Univ., Calif.). pp 261-86 of Natural Electromagnetic Phenomena Below 30 kc/s. Bleil, D. F. (ed.). New York, Plenum Press, 1964.

From NATO Advanced Study Institute, Bad Homburg, Ger., July 22–Aug. 2, 1963. See CONF-630703.

Results of some of the research on whistlers and vlf emissions are reviewed, and the spectra of vlf phenomena observed at geomagnetically conjugate points are presented. (J.H.M.)

41950 MICROPULSATIONS AT NEAR CONJUGATE STATIONS IN THE AURORAL ZONES AND THEIR ASSOCIATION WITH OTHER IONOSPHERIC PHENOMENA. Wright, Charles (Defence Research Board of Canada, Esquimalt, British Columbia). pp 287-318 of Natural Electromagnetic Phenomena Below 30 kc/s. Bleil, D. F. (ed.). New York, Plenum Press, 1964.

From NATO Advanced Study Institute, Bad Homburg, Ger., July 22–Aug. 2, 1963. See CONF-630703.

Results of a joint operation with Stanford University at Fort Churchill, Great Whale River and its near conjugate at Byrd Station are reported. On the assumption that data recorded at conjugate points will be very similar and will occur nearly simultaneously, attention was focused on the micropulsation and magnetograph "events" which occur quite frequently and introduce Birkeland's polar elementary storms. These have adequately sudden commencements to enable them to be timed with an accuracy of about ½ minute for a single micropulsation event. These events are preceded by a quiet interval and followed by bays, or DP's. There is a pronounced difference between the daytime and the nighttime regimes, records of the former often

being of regular (Pc) shapes and the latter nearly always of irregular shape (Pt) with components of much higher frequency (riders). The duration of these riders is seldom longer than eight minutes. Simultaneous auroral events and activity also show similar differences between the daytime and nighttime regimes and the evidence suggests the same is also true of ionospheric absorption and hiss. All these ionospheric events occur simultaneously when measured at the near-conjugate sites of Great Whale and Byrd and sometimes also at Churchill. They occur most frequently in the two hours ending 04 G.M.T. which is not far from geomagnetic midnight at Great Whale. The events can also be recorded on sensitive micropulsation instruments in middle latitudes, presumably as "leakage" currents from the auroral electrojets. Those which include the higher frequency riders, which also appear nearly simultaneously with the negative H events in the auroral zones, have a pronounced maximum of occurrence at Victoria about midnight local mean time. The events can also sometimes be recognized on mid-latitude magnetograms as small perturbations if it is known from other sources when to look for them. It is suggested that the opportunity exists of examining in more detail the relative importance of local mean and geomagnetic time in the incidence of these events in different longitudes around the globe and the difference in form between daytime and nighttime events. In the frequency range of 0.005 to 3 cps, with which the discussion is almost entirely concerned, the balance of evidence is that conjugate points in the auroral zones are of fleeting duration in the sense that points which are conjugate one day are not necessarily conjugate next day or next week. It seems that the origin of the events lies within the magnetosphere, but a direct relation with fluctuations in the solar wind cannot be excluded. (auth)

41951 MICROPULSATIONS OF THE EARTH'S ELECTROMAGNETIC FIELD IN THE FREQUENCY RANGE 0.1-10 CPS. Jacobs, J. A. (Univ. of British Columbia, Vancouver). pp 319-49 of Natural Electromagnetic Phenomena Below 30 kc/s. Bleil, D. F. (ed.). New York, Plenum Press, 1964.

From NATO Advanced Study Institute, Bad Homburg, Ger., July 22–Aug. 2, 1963. See CONF-630703.

Various types of geomagnetic micropulsations are discussed, and samples of recorded signals are shown. Observational results obtained from a number of stations over a period of several years are analyzed and compared. Geographic and geomagnetic coordinates of the recording stations referred to are listed. The discussion is limited to micropulsations whose ultimate source lies beyond the ionosphere. (J.H.M.)

41952 SUMMARY OF THE OBSERVED CHARACTERISTICS OF GEOMAGNETIC MICROPULSATIONS. Heirtzler, J. R. (Columbia Univ., Palisades, N. Y.). pp 351-72 of Natural Electromagnetic Phenomena Below 30 kc/s. Bleil, D. F. (ed.). New York, Plenum Press, 1964.

From NATO Advanced Study Institute, Bad Homburg, Ger., July 22–Aug. 2, 1963. See CONF-630703.

The general nature of geomagnetic micropulsations is discussed. Consideration is given to the following: (1) variation of characteristics over small and large distances, (2) variation of frequency of occurrence of Pc's with time of day and longitude, (3) variation of Pc period with latitude, and (4) correlations of micropulsations with other phenomena. Data from scientific satellites and space vehicles are reviewed. (J.H.M.)

41953 SPECTRAL, CROSS-SPECTRAL, AND BISPECTRAL ANALYSIS OF LOW FREQUENCY ELECTROMAGNETIC DATA. Madden, T. (Massachusetts Inst. of Tech., Cambridge). pp 429-50 of Natural Electromagnetic Phenomena Below 30 kc/s. Bleil, D. F. (ed.). New York, Plenum Press, 1964.

From NATO Advanced Study Institute, Bad Homburg, Ger., July 22–Aug. 2, 1963. See CONF-630703.

The techniques and the significance of various spectral and higher order spectral analyses are examined, and examples of the application of these analyses to geophysical electromagnetic data are given. (auth)

41954 ORDERED MAGNETIC FIELD OF THE MAGNETOSHEATH. Fairfield, D. H. (Goddard Space Flight Center, Greenbelt, Md.). 35p. (CONF-670429-12). DTIE.

From 48th Annual Meeting of American Geophysical Union, Washington, D. C.

Simultaneous data from the IMP 1 and IMP 2 satellites in interplanetary space have revealed that magnetic field discontinuities seen at one satellite are subsequently seen at the other satellite with delay times which are consistent with the idea of magnetic fields frozen in the solar wind being convected away from the sun with the solar wind velocity. A one to one correspondence of discontinuities at the two satellites persists even when one of the satellites is in the magnetosheath, showing that interplanetary fields are convected into the magnetosheath. Analysis of the directional distribution of magnetosheath fields and their relation to simultaneously measured interplanetary fields shows that as the magnetosheath fields are convected around the magnetopause by the solar plasma they undergo distortion from their interplanetary values until they are aligned tangent to the magnetopause. A hydromagnetic interpretation of these results is that interplanetary field lines, after being convected through the earth's bow shock, become draped around the magnetosphere with the sense of the magnetosheath field being that of the incoming interplanetary field. (auth)

41955 POLAR MAGNETIC DISTURBANCES AND THE INTERPLANETARY MAGNETIC FIELD. Fairfield, D. H. (Goddard Space Flight Center, Greenbelt, Md.). 28p. (CONF-670429-13). DTIE.

From 48th Annual Meeting of American Geophysical Union, Washington, D. C.

IMP 2 magnetic field measurements in the magnetosheath and in interplanetary space have been compared with polar magnetic disturbances. Ground disturbance on a 2.5-minute time scale is represented by the universal time index AE prepared from the digitized magnetograms of six auroral zone observatories. The AE index is compared to the satellite field measurements for intervals totaling more than 600 hours in October and November 1964. Investigation of the magnetosheath or interplanetary directions distributions when ground conditions are quiet or disturbed shows that southward fields are associated with disturbed conditions and northward fields with quiet times. Large disturbances are found to correspond almost exclusively to southward fields and especially to large southward fields. The results indicate the importance of the magnetic field in the coupling mechanism which allows solar wind plasma energy to be converted into energy associated with the ionospheric currents of the auroral electrojet. The results support the reconnection field model where interplanetary field lines connect to geomagnetic field lines producing plasma flow in and around the magnetosphere which drives the high-latitude currents. (auth)

41956 FAST NEUTRON LATITUDE VARIATIONS IN THE ATMOSPHERE AT SOLAR MINIMUM. Holt, Stephen S. New York, New York Univ., 1966. 159p.

Thesis.

A series of six high-altitude balloon flights, in which phoswich-type fast neutron scintillation detectors were carried, were launched between September 1964 and March 1965 at three latitudes. The flights attained altitudes of about 120,000 feet at Sioux Falls, S. D., geomagnetic latitude 53°N, Palestine, Texas, geomagnetic latitude 42°N, and Hyderabad, India, geomagnetic latitude 8°N. The detector was sensitive to neutrons in the energy range 1 to 10 MeV, and a seven-channel light-pulse analyzer permitted the evaluation of the energy spectrum in this range. Data were obtained from ground level to about 4 g/cm^2 at the three latitudes; an extrapolation technique was used to estimate the neutron albedo. Data have also been used from a flight from Fort Churchill, Canada, geomagnetic latitude 69°N, during August 1965 and conducted by another member of the NYU Cosmic-Ray Group, in the evaluation of the variations of neutron flux and energy spectrum with altitude and latitude at solar minimum. (Disser. Abstr.)

41957 PEGASUS I: OBSERVATIONS OF THE TEMPORAL BEHAVIOR OF THE INNER BELT ELECTRONS, 1965-1966. Rosen, A. (TRW Systems, Redondo Beach, Calif.); Sanders, N. L.; Shelton, R.; Potter, R.; Urban, E. 51p. (CONF-670429-14). DTIE.

From 48th Annual Meeting of American Geophysical Union, Washington, D. C.

Three Pegasus satellites were launched in similar orbits in February, May, and June 1965. Each spacecraft carried an omnidirectional electron spectrometer having two integral energy channels with E ~ 0.5 MeV and E ~ 1.9 MeV. The discussion is mostly concerned with the data obtained with Pegasus I during 1965 and 1966. The following observations of the inner-belt electrons relate to the physical process responsible for the loss of electrons from this region: (a) the decay of the 0.5-MeV electron flux at L shells less than 1.2 was clearly not exponential during the period of observation; the departure from exponential was due to a long-term flux enhancement by a factor as high as four from June 1965 to August 1965; and this enhancement was related to but not clearly correlated with magnetic activity; (b) for L ≈ 1.6 and $B/B_0 > 2.8$ the decay constant shows a strong B dependence; and (c) a study of the quasi-trapped flux shows

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Refer also to abstract 42480.

41958 (AD-644985) PREDICTION OF THE TEMPERATURE-DEPENDENT STATIC FORM FACTOR IN He I AND He II. Research Paper. Etters, Richard D. (Douglas Aircraft Co., Inc., Huntington Beach, Calif. Advanced Research Lab.). Sept. 1966. 32p. (DARL-16). CFSTI.

A method is presented for predicting the temperature-dependent properties of the static form factor in He I and He II at low momenta. The prediction is based upon the observation that a single coherent, collective mode of excitation predominates for temperatures $\theta \leq 2.57°K$ and momenta $k \simeq 1/0.6A$. An expression is developed for the dissipative part of the density-density response function CHI'' (k, Ω) in the collisionless regime. This result exhibits a slight temperature-dependent energy shift in the position of the main resonance from its value at $\theta = 0°K$. However, the 'sharp resonance' structure is retained, reflecting the fact that the collective mode, which is the principal contributor to CHI'' (k Ω) in the regime considered, exists as a nearly independent mode of excitation for all temperatures $\theta \leq 2.57°K$. The expressions for the dynamic and static form factors are derived. They appear to be insensitive to superfluid behavior. The temperature dependence of the static form factor Sk θ for $0 \leq \theta \leq 2.57°K$ is summarized by the inequalities $\delta - Sk/\delta - \theta > 0$ for $k < 1/0.38$ A and $\delta - Sk/\delta - \theta < 0$ for $k > 1/0.38$ A. (auth) (TAB)

41959 (AD-644992) PERSISTENT CURRENTS IN SUPERCONDUCTING RINGS CONTAINING JOSEPHSON JUNCTIONS. Research Paper. Jacobson, Donald A. (Douglas Aircraft Co., Inc., Huntington Beach, Calif. Advanced Research Lab.). Feb. 1966. 8p. (DARL-4). CFSTI.

A recent experiment by T. I. Smith (Phys. Rev. Letters 15: 460(1965)) has demonstrated that a persistent current can be set up in a closed superconducting circuit containing a Josephson function. It is shown that this aspect of the Josephson effect can be handled with the Ginzburg-Landau equations following a model developed in a recent paper (D.A. Jacobson, Phys. Rev., 138A: 1066(1965)). (TAB)

41960 (AD-645750) TECHNIQUE FOR FABRICATION OF $Al/Al_2O_3/Pb$ SUPERCONDUCTING TUNNEL DIODES. Instrumentation Papers. Silva, Jose H. (Air Force Cambridge Research Labs., L. G. Hanscom Field, Mass.). Nov. 1966. 16p. (AFCRL-66-750). CFSTI.

The report describes an improved method of growing $Al/Al_2O_3/Pb$ superconducting tunnel diodes. Since the resistance of the diode is dependent upon the thickness of the oxide layer, this layer must be carefully controlled in order to fabricate diodes of the desired resistance in a reproducible manner. The key to this method is a substrate holder which allows the entire process to be completed under vacuum. (auth) (TAB)

41961 (N-67-22473) NEW EFFECT IN THE LOW MAGNETIC FIELD ULTRASONIC ATTENUATION OF IMPURE SUPERCONDUCTING NIOBIUM. Gottlieb, M.; Jones, C. K. (Westinghouse Research Labs., Pittsburgh, Pa.). Nov. 10, 1966. 10p. (NASA-TM-X-83423). CFSTI.

Changes have been found in the ultrasonic attenuation of superconducting niobium at magnetic fields less than 20% of H_{c1}. An interpretation is made based upon the effects of low critical field impurity phases. (auth) (TAB)

41962 (NP-16945, pp 122-32) OPTIMIZATION OF CONDUCTION AND INDUCED CURRENTS IN TYPE-II SUPERCONDUCTORS. LeBlanc, M. A. R.; Griffiths, D. J.; Belanger, B. C.; Chang, C. T. M.; Mattes, H. F.; McSweeney, D. (University of Southern California, Los Angeles. Electronic Sciences Lab.). Contract AT(11-1)-113.

It is shown that (1) magnetization currents induced by a decrease of an axial magnetic field enable much larger conduction currents to flow in the wire before a critical threshold is attained and (2) the presence of a conduction current in an immersed axial magnetic field can lead to considerably enhanced magnetic moments when the magnetic field is reduced. (M.O.W.)

41963 PHONON SPECTRUM OF THE SUPERCONDUCTING MODIFICATION OF BISMUTH. Zavaritskii, N. V. (Inst. of Physics Problems, Moscow). JETP Lett. (USSR)(Engl. Transl.), 5: 352-5(June 15, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 5: 434-8(June 15, 1967).

Bismuth was investigated by the tunnel-effect method in order to measure the gap Δ_0 in the electron spectrum of this superconductor and to obtain information on the phonon spectrum distribution density. Tunnel junctions between an oxidized film of aluminum and bismuth condensed at 2°K were investigated. Results are shown. The transition of the bismuth into the superconducting crystalline modification is apparently accompanied by an essential change in the distribution density of the phonon spectrum. (M.H.R.)

41964 EXPERIMENTAL INVESTIGATION OF THE SURFACE SUPERCONDUCTIVITY OF NIOBIUM. Akhmedov, S. Sh.; Karasik, V. R. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR)(Engl. Transl.), 5: 358-60(June 15, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 5: 442-5(June 15, 1967).

Cylindrical niobium samples of 0.4-mm diameter and 15-mm length subjected first to thermal etching in oil-free vacuum of 10^{-7} torr at a temperature close to melting were investigated. Control measurements of the sample quality, made in the range $O < H_0 < H_{c2}$ by a ballistic method, have demonstrated the absence of quenched magnetic moments. Comparison of the theoretical and experimental curves has shown the following: In the region $H_0/H_{c2} \sim 1$ the experimental plot of $-4\pi M_c(H_0/H_{c2})$ agrees qualitatively with the theory. When $H_0 \rightarrow H_{c2}$ the experimental data deviate markedly from those predicted by the theory. (M.H.R.)

41965 PRESENT STATE OF TECHNIQUES OF CONSTRUCTION OF SUPERCONDUCTOR ELECTROMAGNETS. Pasotti, G.; Sachetti, N.; Sacerdoti, G.; Sanna, G. (CNEN, Italy). Elettrotecnica, 54: 80-6(1967). (In Italian).

A general introduction to superconductors is given. Magnetic properties of samples of Nb_3Sn and V_3Ga prepared by several routes are plotted, and the methods discussed. The latter is based on Kunzler's method; for the former, the preparations of the Bell Telephone Laboratories, General Electric Company, the National Research Corporation, and RCA are cited. In addition, the properties of Nb-Zr are outlined, and those of Nb-Ti mentioned. Construction of superconductor magnets is then reviewed, with attention paid to fluid pumps. Several outlooks for use of such equipment are suggested. In physical research present applications suggest future applications taking advantage of the large useful volume and the fields achievable. (BBB)

41966 SOVIET LOW-TEMPERATURE PHYSICS. Hammel, Edward F. Phys. Today, 20: No. 8, 21-7(Aug. 1967).

The facilities, personnel, and research programs in low-temperature physics laboratories in Kharkov, Tbilisi, and Leningrad are described. (M.H.R.)

41967 SOLID HELIUM. Bertman, Bernard; Guyer, Robert A. Sci. Amer., 217: 85-96(Aug. 1967).

Properties and characteristics of solid helium are reviewed, along with various experiments on specific heat, thermal conductivity, exchange interactions, etc. (W.D.M.)

41968 MAGNETIC-FIELD DEPENDENCE OF JOSEPHSON CURRENT INFLUENCED BY SELF-FIELD. Yamashita, Tsutomu; Onodera, Yutaka (Tohoku Univ., Sendai). J. Appl. Phys., 38: 3523-5(Aug. 1967).

The magnetic-field dependence of dc Josephson current I_J was measured using cross-type square junctions made of S_n thin films. The results and analysis indicate that owing to the self-field of I_J, the periodic pattern of I_J on magnetic field is modified and the value of the maximum I_J becomes smaller than theoretically expected value obtained Ambegaokar and Baratoff. (auth)

41969 MAGNETIZATION OF SUPERCONDUCTING CARBIDES. Narlikar, A. V.; Dew-Hughes, D. (Univ. of Lancaster, Eng.). J. Mater. Sci., 2: 496-8(Sept. 1967).

A study of the magnetisation of some annealed samples of niobium and tantalum monocarbides at 4.2°K is described. Chemical analysis indicated that the specimens, which were originally deficient in carbon, picked up some carbon during the annealing treatment. Compared with the as-received specimens the magnetisation curve of the annealed samples of niobium carbide showed a decrease in magnetic hysteresis. This decrease is belived to be due to a removal of barriers causing hindrance to flux movement. It is known that various crystal imperfections, such as dislocations, precipitates, etc., can interact with supercurrent vortices and cause flux pinning. A reduction in the density of holes and cavities after annealing is perhaps the most significant cause of the observed decrease in hysteresis. An interesting feature of the magnetisation curves was the increase observed in the upper critical field, H_{c2}, after annealing. H_{c2} increased from an initial value of 8,000 Oe to 12,000 Oe. This must have been due to the increased carbon content after annealing, which increased the critical temperature, T_c, and hence the critical field. In contrast to niobium carbide, specimens of tantalum carbide showed a considerable increase in magnetic hysteresis after annealing. There was evidence that in the annealed specimens the carbon content was in excess of that required for stoichiometry and that this excess carbon had precipitated out; this may account for the increased hysteresis. An interesting effect observed in detailed magnetisation studies of the as-received specimens was that flux jumps occurred at fields much smaller than the field for largest magnetisation. This suggested that the as-received material was very inhomogeneous and contained large volumes whose com-

position was such that the critical temperature was below 4.2°K. The jumps correspond to the flux rapidly penetrating across these non-superconducting regions. The annealed material did not show flux jumps. It is concluded that these carbides are type-II superconductors, whose critical temperature, upper critical field, and degree of irreversibility are strongly affected by carbon content and microstructure. (UK)

41970 SUPERCONDUCTIVITY OF Cd–Bi EUTECTIC SOLDER. Fassnacht, R. E.; Dillinger, J. R. (Univ. of Wisconsin, Madison). J. Appl. Phys., 38: 3667-8(Aug. 1967).

Measurements are presented which show that the superconducting transition temperature of a eutectic alloy of Cd–Bi is 0.53°K in zero magnetic field. Critical-field measurements are given from which $(dH_c/dT)_{T\to Tc}$ is found to be 91 Oe/°K. These results are discussed in terms of the phase diagram of the Cd–Bi system and in terms of the use of Cd–Bi eutectic as a solder in constructing apparatus for use at very low temperatures. (auth)

41971 SUPERCONDUCTIVITY IN THE REGION OF CONTACT OF TWO MEDIA. Chaplik, A. V. (Institut Fiziki Poluprovodnikov, Novosibirsk, USSR). Fiz. Tverd. Tela, 9: 701-3 (Mar. 1967). (In Russian).

The contact of two semiconducting films with various concentrations of electrons and different numbers of effective contact bonds is examined. It is shown that it is possible for the critical temperature of the composite system to be greater than the critical temperatures of its components. For critical temperatures of the exponential type $\omega_\theta \exp(-2\pi^2/mp_\theta|\lambda|)$, the parameter $p_\theta|\lambda|$ is demonstrated to be given by the product p_m, which is larger than the Fermi impulses of the two substances in combination λ_2 and λ_1 (1/L). Other features of the interaction are also developed. (BBB)

41972 STATISTICS AND DYNAMICS OF THE INTERMEDIATE STATE OF SUPERCONDUCTORS OF TYPE I. Haenssler, F.; Rinderer, L. (Univ., Lausanne, Switzerland). Helv. Phys. Acta, 40: 659-87(Oct. 1, 1967). (In French).

Making use of the superconducting powder technique, a systematic experimental investigation of the intermediate state in circular indium and tin disks placed in a perpendicular magnetic field was made. The average spacing of the intermediate-state structure (NI transitions) determined in function of the temperature and the external magnetic field for a series of pure indium samples with various thicknesses is found to be in poor agreement with predictions of the existing theoretical models. The values of the surface energy parameter calculated for those samples by applying different models indicate that Landau's nonbranching model gives the best results for thin samples (thickness about 1 mm), while for thick samples (about 10 mm) a semibranching model would be more realistic. The powder technique is also used to study flux flow phenomena occurring during transitions. In particular, the drift effect on propagating flux bundles is observed in indium and tin and correlated with the Hall effect existing in the normal parts of the sample by means of a simple model. (auth)

41973 SUPERCONDUCTIVITY OF Ni–Sn ALLOY UNDER HIGH PRESSURE. Ponyatovskii, E. G.; Rabin'kin, A. G. (Inst. of Chemical Physics, Moscow). JETP Lett. (USSR) (Engl. Transl), 6: 10-11(July 1, 1967).

Translated from Zh. Eksper. Teor. Fiz., Pis'ma Redakt., 6: 471-473(July 1, 1967).

It is known that high pressure produces in Bi–Sn alloys a phase whose structure has not yet been determined. The possibility was studied that this phase can be conserved (by deep cooling followed by removal of the pressure) and then investigated at atmospheric pressure. Its superconducting properties were studied and, in particular, the superconducting transition temperature T_c and the temperature interval in which it is stable. This phase was found to have T_c = 7.88°K and to be stable up to –105°C. (M.H.R.)

41974 ^{3}He–^{4}He DILUTION REFRIGERATORS. Varoquaux, E. (Institut d'Electronique Fondamentale, Orsay, France). pp 169-75 of Polarized Targets and Ion Sources. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, [1967].

From Conference on Polarized Targets and Sources, Saclay, France, Dec. 5–9, 1966. See CONF-661205.

The working principle of the ^{3}He–^{4}He refrigeration cycle, which is based on the phase separation these solutions undergo below a certain critical temperature, is discussed. The thermodynamical properties of these solutions are described by the enthalpy H. The H-diagram is derived using the Landau–Pomeranchuk model for dilute ^{3}He–^{4}He solutions. (W.H.K.)

41975 THREE-PHONON PROCESS AND THE PROPAGATION OF SOUND IN LIQUID ^{4}He. Abraham, B. M.; Eckstein, Y.; Ketterson, J. B.; Kuchnir, M. (Argonne National Lab., Ill.). Phys. Rev. Lett., 19: 690-2(Sept. 18, 1967).

The current theoretical formulations of the three-phonon mechanism for the velocity dispersion and for the attenuation of sound in liquid He-4 are shown to be incompatible with new experimental data. (auth)

41976 FAR-INFRARED ABSORPTION IN SUPERCONDUCTING AND NORMAL LEAD. Drew, H. D.; Sievers, A. J. (Cornell Univ., Ithaca, N. Y.). Contract AT(30-1)-2391. Phys. Rev. Lett., 19: 697-9(Sept. 18, 1967). (NYO-2391-51).

No far-infrared absorption was observed below the gap for the superconducting state but an irregular frequency dependence of the surface impedance was found for the normal state. (auth)

41977 SUPERCONDUCTIVITY OF BORIDES OF TRANSITION AND RARE EARTH METALS. Shulishova, O. I.; Shcherbak, I. A. (Inst. of Problems of Study of Materials, Kiev). Izv. Akad. Nauk SSSR, Neorg. Mater., 3: 1495-7(Aug. 1967). (In Russian).

Syntheses of group IV metal monoborides with NaCl-type crystal lattice and tantalum monoborides were studied. Tabulated data are given on the superconductivity of Zr, Hf, Ta, Ca, Y, La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Yb, Sc, and Th mono- and hexaborides and of the temperature dependence of LaB_6 and (LaB_6 + LaB_4). (R.V.J.)

41978 FLUX-JUMPING PATTERNS OF SUPERCONDUCTING SOLENOIDS IN A CLOSED SYSTEM. Kuroda, Kunishige; Kimura, Hiroshi (Hitachi Ltd., Toyko). Jap. J. Appl. Phys., 6: 1242-7(Oct. 1967).

By observing the flux-jumping behavior of three kinds of closed-wound superconducting solenoids made of Nb–25% Zr alloy wire, it was found that flux-jumping patterns varied remarkably with the size of a solenoid. The following three points were discussed: the size dependence, upper limit and degradation effect of induced supercurrents, and relation between the flux jumping in a closed system and quenching in an open system. (auth)

41979 APPARENT NEGATIVE THERMAL CONDUCTIVITY IN THE FLUX FLOW STATE OF TYPE-II SUPERCONDUCTORS. Ohta, Tokio (Defense Academy, Yokosuka, Japan). Jap. J. Appl. Phys., 6: 1236-41(Oct. 1967).

A theory of thermal conductivity in the flux flow state of type-II superconductors where an electric current and a thermal gradient coexist is developed, and the conditions of the sign reversal of the net thermal conductivity are sought out in detail. The condition for negative sign in a typical case is $E > 5.2 \times 10^{-9} H^4$, where E, the electric field across the sample and H, the applied magnetic field, are measured in V/cm and Oe, respectively. The effect of reversal of direction of the magnetic field on the thermal conductivity and the negative figure of merit are discussed in regard to the effective thermoelectric effects. (auth)

41980 SUPERCONDUCTIVITY OF THREE METASTABLE FORMS OF GALLIUM. Bosio, Louis; Cortes, Robert; Defrain, Andre; Epelboin, Israel (Faculte des Sciences, Paris). Compt. Rend., Ser. A and B, 264: 1592-4(June 5, 1967). (In French).

It is shown that three metastable forms of gallium present superconductivity transitions: beta Ga and another form are superconductors of type I, whereas a third phase is a superconductor of type II. (tr-auth)

41981 THEORY OF SUPERCONDUCTIVITY IN PARALLEL LAYERS OF SMALL THICKNESS. Raufuss, Henning (Univ., Goettingen, Ger.). Z. Naturforsch., 22a: 985-97(July 1967). (In German).

The Gorkov equations are solved for ideal planar films of superconductors. For the purpose of comparison, two different formulations of the self-consistency condition are used; the first is characterized by a cutoff factor in the energy integral, the second by the termination of the ω summation at the same cutoff value. Certain values of the film thickness (those corresponding to resonance intervals in the sense of Thompson and Blatt) are excluded, but they are not decisive to this treatment. By this means, a fairly accurate check of the error in the approximation is made possible. This allows a quantitative comparison of the critical temperatures and of the two forms of the gap function calculated from the two formulations of the basic equations. At absolute zero, both formulations of the theory become equivalent and lead to essentially identical relations between the gap function and film thickness. However, the critical temperature which results from the termination of the ω summation is noticeably higher than that calculated with the help of the energy cutoff. (auth)

41982 SOME PROPERTIES OF SUPERCONDUCTING COMPOUNDS OF THE V_3Si TYPE. Levanyuk, A. P.; Suris, R. A. Usp. Fiz. Nauk, 91: 113-20(Jan. 1967). (In Russian).

The various features distinguishing ordinary superconductors

from those having high T_c are described and an attempt is made to determine the causes of the high temperature. A hypothesis is advanced, supported by a number of published results, that V_3Si and similar compounds undergo a structural second-order phase transition near the critical point, and that the large differences observed between T_c values of two substances having similar structures can be attributed to differences in the characteristic parameters of the transition. Another factor greatly affecting T_c is shown to be the dependence on the shear deformation, and especially the large differences in the shear deformations in different crystallographic axes. A relation may also exist between T_c and the anisotropy of the electronic properties of V_3Si, which is also related to structural factors. The last distinguishing feature of V_3Si discussed is sound absorption, the experimental results on which deviate greatly from those predicted by the Bardeen–Cooper–Schrieffer theory for ordinary superconductors. (ATD)

41983 ELECTRICAL, MAGNETIC, AND SUPERCONDUCTING PROPERTIES OF COPPER DISULFIDE. Munson, Ronald A.; DeSorbo, Warren; Kouvel, J. S. (General Electric Research and Development Center, Schenectady, N. Y.). J. Chem. Phys., 47: 1769-70(Sept. 1, 1967).

The physical properties of copper disulfide are correlated with those of the disulfides of the transition elements manganese through nickel, all of which have the pyrite structure, by the consideration of the effect of the anion crystal field upon the d-electron energy levels. Copper disulfide shows a weak paramagnetism, which appears to follow a Curie–Weiss law below 100°K with a small localized moment, $\mu_{eff^2} = 0.34\ \mu_{B^2}$, and a paramagnetic Curie temperature equal to −25°. It is a metallic conductor with a specific resistivity of 2×10^{-3} Ω-cm at room temperature. The superconducting transition temperature is 1.56° ± 0.04°K. (auth)

41984 THE EXPANSION EJECTOR, A NEW CRYOGENIC DEVICE. Rietdijk, J. A. (Phillips Research Labs., Eindhoven). Philips Tech. Rev., 28: 243-5(1967).

For the liquefaction of helium or the continuous refrigeration at a few °K for use of a Joule–Thomson cycle is essential. In this cycle the suction pressure of the compressor must be lower than the vapor pressure of the liquefied helium, so that very large compressors are required if the lowest temperature to be obtained is much lower than 4.2°K. A new device, the "expansion ejector," replacing the conventional expansion value, makes it possible to decouple the vapor pressure of the liquid produced and the compressor suction pressure. The expansion ejector, which drives an additional refrigeration cycle, acts as an expansion valve in the main cycle and as a compressor in the additional cycle. Experimentally a pressure of 5 torr (corresponding to 2.3°K) at the suction side of the expansion ejector has been obtained, using a compressor suction pressure of 1 bar. For liquefaction at 1 bar, the suction pressure of the compressor can now be 2.5 to 3 bar corresponding to a compressor much smaller than in the conventional cycle. The expansion ejector is a very simple device: it has no moving parts and it is no larger than a matchbox. (auth)

41985 CONTRIBUTION OF THERMAL NOISE TO THE LINE WIDTH OF JOSEPHSON RADIATION FROM SUPERCONDUCTING POINT CONTACTS. Silver, A. H. (Ford Motor Co., Dearborn, Mich.); Zimmerman, J. E.; Kamper, R. A. Appl. Phys. Lett., 11: 209-11(Sept. 15, 1967).

The line width of the Josephson oscillations of a voltage-biased superconducting point contact has been measured between 1.4°K and 8°K, with bias resistors R between 1.7×10^{-10} Ω and 2.6×10^{-5} Ω. Within the experimental accuracy the line width is proportional to RT, and is consistent with the estimated theoretical value $8kTR/\Phi_0^2$, where k is Boltzmann's constant and Φ_0 is the flux quantum. Line widths below 0.1 Hz have been observed at 4.2°K for $R = 1.7 \times 10^{-10}$ Ω, providing an experimental upper limit to other noise sources and indicating that this is useful as a voltmeter and thermometer below 10^{-16} V and 10^{-4}°K. (auth)

41986 SUPERCONDUCTING TRANSITION AND MAGNETORESISTANCE OF A SINGLE-CRYSTAL NIOBIUM SPECIMEN IN A WEAK FIELD AT 4.2°K. Perriot, G. (Centre d'Etudes Nucleaires, Saclay, France). J. Phys. (Paris), 28: 472-80(May-June 1967). (In French).

A study of the electrical resistance of a niobium single crystal, at 4.2°K, from the beginning of the superconducting transition to 80 kOe is reported. Critical fields H_{c2} and H_{c3} were determined. Influences on superconducting transition of current density, field-current angle, crystal anisotropy, and magnetoresistance were studied. Variation laws of low-field transverse and longitudinal magnetoresistance were determined. (auth)

41987 SUPERCONDUCTIVITY AND HARDNESS. Matthias, B. T. (Univ. of California, La Jolla, Bell Telephone Labs., Murray Hill, N. J.). Phys. Lett., 25A: 226-7(Aug. 14, 1967).

Correlations in metals between their high-temperature properties and their superconducting behavior have begun to appear recently. (auth)

41988 GROUND-STATE ENERGY SHIFT IN SUPERCONDUCTOR DUE TO s-d INTERACTION. Nam, S. B.; Woo, J. W. F. (Rutgers State Univ., New Brunswick, N. J.). Phys. Lett., 25A: 224-5(Aug. 14, 1967).

The possibility that the s–d interaction gives rise to a bound state between conduction electrons and a localized spin in a superconductor is discussed. It is shown that a singlet bound state is energetically favorable when λ_0 is greater than Δ, where λ_0 is the binding energy of the singlet in the normal state and Δ is the zero temperature BCS gap parameter. (auth)

41989 SUPERCONDUCTIVITY IN TIGHT BINDING SYSTEMS. Tareeva, E. E. (Inst. of High Pressure Physics, Moscow). Phys. Lett., 25A: 252-3(Aug. 14, 1967).

The principal role of d electrons in superconductivity of transition metals and the dependence of critical temperature upon pressure are considered, in the frame of tight-binding approximation. (auth)

41990 CALCULATION OF LOSSES IN A TYPE-II SUPERCONDUCTING WIRE IN ALTERNATING CURRENT AND MAGNETIC FIELD. Mailfert, A. (Laboratoire Central des Industries Electriques, Fontenay-aux-Roses, France). Phys. Lett., 25A: 247-8(Aug. 14, 1967). (In French).

The results of the measurement of the losses occurring on a type-II superconducting wire are interpreted. This interpretation starts with the determination of the magnetic field at the surface of the sample, which is assumed to be nearly perfectly diamagnetic. (tr-auth)

41991 THE EXACT κ AND FIELD DEPENDENCE OF THE MAGNETIC FIELD PENETRATION OF THE MEISSNER STATE. Fink, H. J.; Kessinger, R. D. (Atomics International, Canoga Park, Calif.). Contract AT(04-3)-701. Phys. Lett., 25A: 241-2 (Aug. 14, 1967).

The exact magnetic field dependence of the magnetic field penetration depth was calculated for various values of the Ginzburg–Landau parameter κ. (auth)

41992 SUPERCONDUCTIVITY IN SULFO- AND SELENOSPINELS. Van Maaren, N. H.; Schaeffer, G. M.; Lotgering, F. K. (Philips Research Labs., Eindhoven, Netherlands). Phys. Lett., 25A: 238-9(Aug. 14, 1967).

Superconductivity was found in some metallic sulfo- and selenospinels. The first appearance of superconductivity was detected at 4.80°K for $CuRh_2S_4$, at 3.49°K for $CuRh_2Se_4$, and at 4.45°K for CuV_2S_4. No transition was found for $CuTi_2S_4$ and $CuCo_2S_4$ above 0.05°K. Preliminary results on mixed crystal system are reported. (auth)

41993 THE λ-POINT, ENTROPY, AND DENSITY OF ROTATING HeII. Pobell, F.; Schoepe, W.; Veith, W. (Technische Hochschule, Munich). Phys. Lett., 25A: 209-10(Aug. 14, 1967).

The λ point, entropy, and density of He II have been found to be independent of rotation up to $\omega = 110\ sec^{-1}$ to within $\Delta T_\lambda = 10^{-5}$°K $\Delta S = 7 \times 10^{-4}$ joule/mole °K, and $\Delta\rho/\rho = 2 \times 10^{-6}$, respectively. (auth)

41994 PARAMAGNETIC EFFECTS OF THE ALTERNATING FIELD SUSCEPTIBILITY OF SUPERCONDUCTING TANTALUM. Van Engelen, P. P. J.; Bots, G. J. C.; Blaisse, B. S. (Technische Natuurkunde, Delft, Netherlands). Phys. Lett., 25A: 218-19 (Aug. 14, 1967).

The ac susceptibility χ in a field below H_{c3} is a function of the amplitude h of the alternating field. Under certain conditions differential paramagnetism will be present. This paramagnetism can be correlated with the character of the static magnetization curve in increasing and decreasing field. (auth)

41995 NUCLEAR MAGNETIC RELAXATION TIMES OF ^{3}He IN ^{3}He–^{4}He SOLUTIONS. Sung, C. C. (Ohio State Univ., Columbus). Phys. Lett., 25A: 216-17(Aug. 14, 1967).

The longitudinal and transverse relaxation times T_1 and T_2 of the nuclear spins of ^{3}He in solution in ^{4}He for high and low temperatures are calculated and shown to be equal for reasonable external magnetic fields. The result is compared with experimental data. (auth)

41996 MOBILITY OF ELECTRONS IN DENSE ^{4}He FLUID. Modena, I. (CNEN, Rome); Ricci, F. P. Phys. Lett., 25A: 213-14(Aug. 14, 1967).

Experimental results of mobility of electrons in ^{4}He, at constant density for $2.6 \leq T \leq 10.6$°K and at constant temperature for $0.026 \leq \rho \leq 0.144$ g/cm are reported and discussed. (auth)

41997 ENERGY GAP OF SUPERCONDUCTING Nb_3Sn. Bosomworth, D. R.; Cullen, G. W. (RCA Labs., Princeton, N. J.). Phys. Rev., 160: 346-7(Aug. 10, 1967).

The superconducting energy gap 2Δ of vapor-deposited Nb_3Sn was determined by far-infrared reflectivity measurements. The energy gap of virgin (as-deposited) Nb_3Sn was $(3.77 \pm 0.16)k_BT_c$. After the same sample was mechanically polished and thereby disturbed or damaged, a gap of $1.9k_BT_c$ was observed. The virgin-state energy gap was restored by etching away the damaged surface. It is concluded that the bulk energy gap of Nb_3Sn is $(3.77 \pm 0.16)k_BT_c$. The smaller energy gap is discussed in terms of surface effects and the results of other measurements. (auth)

41998 HYSTERESIS IN SUPERCONDUCTORS. II. EXPERIMENTAL TESTS FOR CRITICAL STATES. Schweitzer, Donald G.; Garber, M. (Brookhaven National Lab., Upton, N. Y.). Contract AT(30-2)-Gen-16. Phys. Rev., 160: 348-58(Aug. 10, 1967). (BNL-10927).

Hysteretic states associated with minor and major hysteresis cycles were investigated to determine their degree of criticality and the extent to which they exist in the volume of the superconductor. A variety of experiments were performed which can distinguish between hysteresis resulting from surface currents and hysteresis due to flux pinning. The measurements include (1) comparison of the temperature dependence of the critical current with the temperature dependence of the remnant magnetization, (2) changes in the remnant magnetization with applied transport currents, (3) comparison of the temperature dependence of remnant magnetization from minor and major cycles, (4) changes of the magnetization in external fields during and after application of transport currents, (5) changes in magnetization in solid and hollow cylinders, and (6) the temperature dependence of remnant magnetization in hollow cylinders of type-I and type-II superconductors, and (7) the variation of critical current with dia. In the systems studied, states were found to be (a) entirely subcritical, (b) partially critical and partially subcritical, and (c) entirely critical in degree. Only a part, and under many conditions none, of the volume was found to exist in the critical state. The experiments show that, in the systems studied, hysteresis is predominantly due to surface currents and not to flux pinning. The pertinence of these experiments to various models for hysteresis and the origin of the surface currents is discussed. (auth)

41999 VOLUME EFFECT FOR MAGNETIC TRANSITION TEMPERATURES OF RARE EARTH–SCANDIUM ALLOYS. Wollan, E. O. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Phys. Rev., 160: 369-72(Aug. 10, 1967). (ORNL-P-2935).

The alloys of the heavy rare earths with scandium have appreciably lower magnetic ordering temperatures than the metals themselves and their alloys with yttrium. The difference between these systems appears to be associated with the effect on the magnetic coupling of the smaller atomic volume of scandium. The Curie temperatures T_C of the Gd–Sc and the Gd–Y alloys are compared over the composition range for which they are ferromagnetic. The coupling energy per gadolinium atom T_C/x in the Gd–Y system is found to be essentially independent of composition whereas there is a linear decrease in this quantity for the Gd–Sc system. The rate of decrease of T_C/x with volume for the alloy system is compared with the corresponding decrease of T_C for pure gadolinium as determined in measurements at high pressures, and the results are found to be in good accord. The Néel-temperature data for the Tb–Sc system are also discussed. (auth)

42000 PRESSURE DEPENDENCE OF THE MAGNETIC TRANSITIONS IN DYSPROSIUM AND ERBIUM. Milton, J. E.; Scott, T. A. (Univ. of Florida, Gainesville). Phys. Rev., 160: 387-92(Aug. 10, 1967).

The effect of hydrostatic pressure on the magnetic transitions of polycrystalline samples of dysprosium and erbium has been studied to 7 kbar. Pressure was generated using a helium–gas system and the transitions were detected by measuring, with a precision ratio-transformer bridge, the self-inductance of a coil containing the samples. For the antiferromagnetic transition of dysprosium we find that dT_N/dP increases in magnitude with pressure, having an initial value of -0.44 ± 0.02°K/kbar and an average of about -0.5° K/kbar. The Néel transition of erbium shows a constant slope of -0.26 ± 0.01°K/kbar. Determination of the ferromagnetic transitions was complicated by a hysteresis effect between warming and cooling data for dysprosium and a rather complicated variation of inductance with temperature for erbium; but with the exercise of systematic experimental procedure, including temperature cycling over a wide range and slow rates of temperature change, it is believed that reliable values for the pressure dependence of the Curie transition were obtained. For dysprosium, an inflection point in the inductance-temperature curve coincided at atmospheric pressure with the reported value of the transition temperature and was taken, therefore, to indicate the transition under high pressure as well, yielding $dT_c/dP = -1.24 \pm 0.10$°K/kbar. For erbium, between 4.2 and 60°K, two peaks were observed on cooling curves and three on warming curves. The low-temperature peak on warming coincided with the reported Curie transition at 20°K and was found to have a pressure dependence of -0.8 ± 0.2°K/kbar. A high-temperature peak coincided on warming curves with a 53.5°K peak that has been reported in specific-heat and magnetic measurements and is also associated with a transition reported at 52°K from neutron-diffraction experiments in which the magnetization transverse to the c axis changes. This peak shows a pressure dependence of -1.3 ± 0.2°K/kbar. A strong peak observed at about 25°K on cooling was pressure-independent, but on warming curves, was located at a slightly higher temperature and was pressure-dependent. The results are compared with other measurements on the rare earths, and with theory. (auth)

42001 FAR-INFRARED ABSORPTION IN SUPERCONDUCTING NIOBIUM ALLOYS. Cappelletti, Ronald Louis. Urbana, Ill., Univ. of Illinois, 1966. 85p.

Thesis.

The widths of the energy gaps in bulk samples of transition metal binary alloys of the system Zr–Nb–Mo have been measured by the absorption of far-infrared radiation. The gap edges are sharp and there is no notable structure on the curves. No attempt was made to compare the shapes of the curves with theory, since certain parameters required for the theoretical calculation were not known. The behavior of the widths of the gaps with alloying follows qualitatively that of the transition temperatures, but the reduced gap widths in two cases are significantly different from the BCS value of 3.52. The relation between the calculated BCS interaction parameter V and the reduced gap width is found to be opposite to that in the simple metals. Results of this and other experiments can be taken to indicate that the interaction parameter V increases by a factor of about four over this alloy series. (Disser. Abstr.)

42002 LOW-TEMPERATURE NUCLEAR SPIN–LATTICE RELAXATION TIMES IN METALS. Anderson, Arthur George. New York, New York Univ., 1958. 105p.

Thesis.

An experimental investigation has been made of the nuclear spin–lattice relaxation times, τ_1, in the metals lithium, sodium, aluminum, and copper. The measurements extended over the range of temperatures between 1.1 and 4.2°K. A combination of nuclear magnetic resonance at fixed frequency and adiabatic variation of the magnetic field was used to measure τ_1 as a function of field between zero and one thousand oersted. The nuclear spin–lattice relaxation times at fields greater than one hundred oersted were found to be independent of magnetic field and inversely proportional to temperature in agreement with theory. The τ_1-temperature products determined experimentally are: $\tau_1T(^7Li) = 44.0 \pm 2.0$ sec deg; $\tau_1T(^{23}Na) = 5.1 \pm 0.3$ sec deg; $\tau_1T(^{27}Al) = 1.80 \pm 0.05$ sec deg; $\tau_1T(^{63}Cu) = 1.27 \pm 0.07$ sec deg. The agreement with theory is within 50% in all four metals. At fields comparable with the nuclear magnetic dipole–dipole fields τ_1 is a function of applied field. Qualitative agreement is obtained with theory for ^{27}Al and ^{63}Cu; detailed agreement is obtained for ^7Li and ^{23}Na. The zero field τ_1-temperature products are: $\tau_1T(^7Li)_0 = 20.5 \pm 2.0$ sec deg; $\tau_1T(^{23}Na)_0 = 2.20 \pm 0.20$ sec deg; $\tau_1T(^{63}Cu)_0 = 0.46 \pm 0.05$ sec deg. A small temperature dependence observed in aluminum gives a $\tau_1T(^{27}Al)_0 = 0.70 \pm 0.05$ sec deg at 4.2°K and a $\tau_1T(^{27}Al)_0 = 0.60 \pm 0.05$ sec deg at 1.3°K. Measurements in the superconducting state of aluminum show a drop in τ_1 of from 0.52 sec at 1.2°K to 0.25 sec at 1.1°K. This result is in agreement with theory based on an energy gap model of the superconductor and is also in agreement with a recent experiment of Hebel and Slichter. (Disser. Abstr.)

42003 SPECIFIC HEAT OF FCC AND D-HCP LANTHANUM FROM 1.0 TO 10.0°K. Johnson, David Lee. Ames, Iowa, Iowa State Univ. of Science and Tech., 1966. 75p.

Thesis.

The specific heat of fcc and d-hcp lanthanum was measured in the temperature range from 1.0 to 10.0°K in both the superconducting and normal states. Values of the electronic specific heat coefficient γ and the Debye temperature θ_D were determined for both phases from the normal state measurements. The Debye temperature was found to be 140 ± 2°K for the fcc phase and 152 ± 1.5°K for the d-hcp phase. Both were constant below about 3°K in agreement with lattice theory. The electronic specific heat coefficients were 11.5 ± 0.25 and 9.40 ± 0.1 mJ/mole°K for the fcc and d-hcp phases respectively. The superconducting state data were analyzed to determine whether either phase of lanthanum deviates significantly from the law of corresponding states and to compare both phases with the BCS theory and with other superconductors. Critical fields of both phases deduced

from these measurements showed good agreement with the law of corresponding states and deviated from the BCS theory in a manner consistent with the measured values of T_c/θ_D, (0.042 for fcc La and 0.032 for d-hcp La). Because this ratio for both phases is comparable to the corresponding ratio for niobium (0.033), a comparison was made with the niobium results of Leupold and Boorse. This comparison showed remarkable similarity between the two metals as the thermodynamic properties of both could be quite well described by a simple scaling of the temperature-dependent BCS energy gap function by a factor of approximately 3.7/3.53. (Disser. Abstr.)

42004 THE BOGOLYUBOV EQUATIONS AND THEIR APPLICATION TO A NORMAL–SUPERCONDUCTING BOUNDARY. Mathews, Wesley Northey Jr. Urbana, Ill., Univ. of Illinois, 1966. 209p.

Thesis.

The Bogolyubov equations are used to investigate the pair potential and the electronic excitations associated with a normal–superconducting boundary in an extreme type I superconductor. The method of the Bogolyubov equations has three advantages, for this calculation, over other methods: the method offers a practical means of investigating the properties of a normal–superconducting boundary for all temperatures below the transition temperature; much of the physical insight associated with single-particle wave functions can be brought to bear, and the effects of nonlocality in the electrodynamics are taken into account from the outset. The possible improvements in and the logical extensions of the investigation are discussed. This investigation should serve as a starting point for a complete, microscopic calculation of the fundamental properties of the intermediate state. Also, the method of solution of the Bogolyubov equations should prove useful for a wide variety of problems. (Disser. Abstr.)

42005 ULTRASONIC AND THERMAL EFFECTS IN SUPERCONDUCTORS. Kagiwada, Reynold Shigeru. Los Angeles, Univ. of California, 1966. 147p.

Thesis.

Some of the properties of three transition metals, niobium, vanadium, and tantalum, have been investigated using the ultrasonic technique. The normal attenuation in niobium possessed a typical electron–phonon behavior with a temperature dependence of $T^{-3.2}$. In the superconducting state, attenuation was measured in both the absence of a magnetic field and at various values of the external magnetic field. From the ratio of superconducting to normal conducting attenuation, the zero-degree energy gaps of niobium, vanadium, and tantalum were determined. For niobium, an energy gap of $2\Delta(0) = 3.64 \pm 0.05\ kT_c$ was found for the [100] direction of propagation, and an energy gap of $3.70 \pm 0.06\ kT_c$ for the [111] direction. These measurements indicate an anisotropy of the energy gap. The zero-degree energy gap for vanadium was $2\Delta(0) = 3.40 \pm 0.07\ kT_c$ in the [110] direction, and $3.10 \pm 0.07\ kT_c$ for tantalum in the [100] direction. The temperature dependence of the energy gap was investigated over a wide temperature range and also close to the transition temperature. These measurements were compared with the Bardeen, Cooper, and Schrieffer theory. For niobium in the mixed state, the propagation of both transverse and longitudinal waves was studied. These measurements were compared with Maki's theory for pure type-II superconductors near the upper critical field. The ratio of superconducting to normal attenuation was found to be proportional to the square root of the upper critical field minus the external magnetic field as Maki had predicted. In tantalum, the usual hysteresis of the ultrasonic attenuation in the intermediate state was found. In the course of the ultrasonic studies, some rather unusual behavior in the mixed state of niobium was observed. Temperature spikes in one-to-one correspondence with ultrasonic attenuation spikes occurred in two irreversible samples of niobium. In one sample, the spikes seemed to be more or less random. In contrast to this, there was regularity in the occurrence of the spikes for the second sample. The cause of these temperature and ultrasonic attenuation spikes is attributed to the jumping of flux bundles. (auth)

42006 STRAIN EFFECTS IN THE TUNNELING CHARACTERISTICS OF SUPERCONDUCTING LEAD. Hodder, Robert Edwin. Chapel Hill, N. C., Univ. of North Carolina, 1966. 196p.

Thesis.

Included in the theoretical section are a critical discussion and redefinition of certain parameters of the Bardeen–Cooper–Schrieffer theory of superconductivity; a detailed calculation, from the basic tenets of the BCS theory, of the superconductor to normal metal tunneling current, which can be related to a new system of excitation spectrum tunneling diagrams; and an outline of the solution to the Eliashberg–Nambu equations of superconductivity for a strained superconductor. The experimental portion describes the measurement of strain-induced shifts in the gap and phonon structure in superconducting lead–insulator–lead tunneling junctions between 1.5 and 4.2°K. Mechanical bending of the glass substrates produced strains between -1.6×10^{-3} and 1.7×10^{-3}. Within these limits, the gap was observed to shift by $d2\Delta(1.5°K)/d\delta = 3.27 \pm 0.09 \times 10^{-3}$ eV/unit strain, where $2\Delta(T)$ is the energy gap as measured by the position of the main peak in the first derivative characteristic at temperature T, and δ is applied strain. The function $d2\Delta(T)/d\delta$ was found to increase with increasing temperature, although not as rapidly as predicted by the BCS theory. Converting this strain dependence into a volume dependence produced reasonable agreement with the results of other measurements. Values of the strain-induced shifts in the phonon structure of the tunneling characteristic were found to vary considerably from peak to peak. However, comparison between these shifts can provide valuable insight into the problem of identifying this structure with Van Hove singularities in the phonon density of states. (Dissertation Abstr.)

42007 HEAT CAPACITY OF DILUTE SOLUTIONS OF LIQUID ^{3}He IN ^{4}He AT LOW TEMPERATURES. Roach, William Ronald. Urbana, Ill., Univ. of Illinois, 1966. 104p.

Thesis.

Heat capacity measurements were made on two dilute solutions of liquid ^{3}He in ^{4}He. These data, taken under saturated vapor pressure at temperatures between .005°K and .20°K, are characteristic of an ideal Fermi gas with m^* dependent only slightly on concentration. The solution with a molar concentration of ^{3}He of (1.32 ± .01)% had a degeneracy temperature of (.141 ± .002)°K and $m^*/m = 2.38 \pm .04$. For the solution with a (5.02 ± .03)% concentration of ^{3}He the degeneracy temperature was (.331 ± .004)°K while $m^*/m = 2.46 \pm .04$. The slight dependence of m^* on concentration can be explained in terms of the Landau theory of a Fermi liquid. The perturbation method, which Bardeen, Baym, and Pines used to determine an effective potential v(q) between ^{3}He quasiparticles from later data on the magnetic properties of these solutions, was used to estimate the low-temperature contribution of the ^{3}He quasiparticles to the thermal conductivity and viscosity of dilute solutions. (Disser. Abstr.)

42008 MAGNETIC PROPERTIES OF DILUTE SOLUTIONS OF LIQUID ^{3}He IN ^{4}He AT LOW TEMPERATURES. Sarwinski, Raymond Joseph. Urbana, Ill., Univ. of Illinois, 1966. 125p.

Thesis.

The spin-diffusion coefficient and magnetic susceptibility of dilute solutions of ^{3}He in ^{4}He have been measured down to about 3m °K. These measurements were made on two solutions of nominal concentrations of 1.3 and 5.0% ^{3}He in ^{4}He under their own vapor pressures. The values of the diffusion coefficient fit T^{*-2} laws below about 10m °K for the 1.3% and below about 30m °K for the 5.0% solutions in agreement with the Landau model of a Fermi liquid. The susceptibility is found to be constant at sufficiently low temperatures also in agreement with the Landau model. Dilute solutions of ^{3}He in ^{4}He are found to behave as weakly interacting Fermi systems with the advantage that the concentration, and therefore the Fermi temperature, can be varied from 0 to about 6% ^{3}He. Since the system is weakly interacting, perturbation theory can be applied and the effective interaction potential between ^{3}He particles can be deduced from measurements of the properties of these solutions at different concentrations. (Disser. Abstr.)

42009 MAGNETIC PROPERTIES OF DILUTE LIQUID ^{3}He–^{4}He SOLUTIONS. Husa, Donald LeRoy. Columbus, Ohio, Ohio State Univ., 1966. 120p.

Thesis.

The nuclear magnetic susceptibility and diffusion coefficient have been measured for dilute liquid ^{3}He–^{4}He solutions. The susceptibility measurements were made on 2% to 15% solutions over the range 0.35 to 2°K. The susceptibility was found to be very close to the ideal Fermi–Dirac form indicating that the effective interactions between the ^{3}He particles are very small. The diffusion coefficient was measured for 2% and 12% solutions from 0.4 to 1.2°K. The diffusion coefficient was found to be inversely proportional to concentration and temperature in the range 0.4 to 0.7°K in agreement with earlier work. The diffusion measurements were characterized by anomalously small spin–spin relaxation times in agreement with the results of other workers. The origin of this small spin–spin relaxation time, T_2, is not known. The spin–lattice relaxation time, T_1, was found to be dependent on relaxation at the walls of the sample container. (Disser. Abstr.)

42010 THE SPECIFIC HEAT AND PHASE SEPARATION CURVE OF DILUTE SOLUTIONS OF LIQUID ^{3}He IN ^{4}He. Skertic, Matthew Michael. Columbus, Ohio, Ohio State Univ., 1966. 139p.

Thesis.

The phase-separation curve for dilute solutions of ^{3}He in superfluid ^{4}He has been studied by measuring the heat capacity of sev-

eral dilute solutions under their own vapor pressure varying in composition from X = 4% ^{3}He to X = 15% ^{3}He at temperatures between 0.07 and 0.70°K. The specific heat above the phase-separation temperature, T_s, after the small phonon and roton contribution of the ^{3}He was subtracted away, was very close to that of an ideal Fermi–Dirac gas of the same ^{3}He number density and with effective mass $m^* = 2.5\ m(^3He)$, in agreement with the Pomeranchuk model. Phase separation as indicated by a discontinuity ΔC in the heat capacity was observed in only the solutions with $X \geq 8\%$. The chemical potentials for the ^{3}He component in each phase of the phase-separated solution may be obtained by applying the Zharkov–Silin model to the upper ^{3}He-rich phase and the Landau–Pomeranchuk model to the lower ^{4}He-rich phase. Equating the chemical potentials and using the measured phase separation temperatures, $T_s(X)$, the binding energy of the ^{3}He atoms in solution $E_3(X)$, expressed as $E_3(X) - L_0^3/R$, where L_0^3 is the latent heat of vaporization of pure ^{3}He at 0°K, may be determined for $8\% \leq X \leq 15\%$. It is found to have a small linear dependence on concentration X. By extrapolating this to lower concentrations, the phase separation curve down to 0°K was calculated, and it is found that ^{3}He remains soluble in ^{4}He up to a concentration X of about 5.5%. (Disser. Abstr.)

Plasma and Thermonuclear Physics

Refer also to abstract 41086.

42011 (AED-C-03-08) DOCUMENTATION OF PLASMA PHYSICS. PART 1. EXPERIMENTAL PLASMA PHYSICS THEORETICAL PLASMA PHYSICS. Bibliography; Author Index; Subject Index. Volume 2. Hilsenbeck, D. (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). May 1967. 178p. Dep.

A bibliography containing 328 articles on various aspects of plasma physics is presented. Author and subject indexes are included. (M.O.W.)

42012 (AED-C-03-09) DOCUMENTATION OF PLASMA PHYSICS. PART 1. EXPERIMENTAL PLASMA PHYSICS THEORETICAL PLASMA PHYSICS. Bibliography; Author Index; Subject Index. Volume 2. Hilsenbeck, D. (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). June 1967. 179p. Dep.

A bibliography containing 324 articles on various aspects of plasma physics is presented. Author and subject indexes are included. (M.O.W.)

42013 (AED-C-03-10) DOCUMENTATION OF PLASMA PHYSICS. PART 1. EXPERIMENTAL PLASMA PHYSICS THEORETICAL PLASMA PHYSICS. Bibliography; Author Index; Subject Index. Volume 2. Hilsenbeck, D. (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). July 1967. 167p. Dep.

A bibliography containing 300 articles on various aspects of plasma physics is presented. Author and subject indexes are included. (M.O.W.)

42014 (NP-16945) CONSOLIDATED SEMIANNUAL PROGRESS REPORT NO. 5 COVERING RESEARCH ACTIVITY DURING THE PERIOD OCTOBER 1, 1966 THROUGH MARCH 31, 1967. (University of Southern California, Los Angeles. Electronic Sciences Lab.). 214p.

Separate abstracts were prepared for three of the sections. (M.O.W.)

For abstracts of individual sections see: 41962, 42051, and 42052.

Confinement and Heating of Plasma

Refer also to abstract 42125.

42015 (AD-647421) FINAL REPORT [ON PHYSICS], NOVEMBER 1, 1964–DECEMBER 31, 1966. Lax, Benjamin; Freeman, Arthur J. (Massachusetts Inst. of Tech., Cambridge. National Magnet Lab.). Jan. 30, 1967. Contract AF49(638)-1468. 46p. (AFOSR-67-0522). CFSTI.

During the contract period important improvements in the high field magnet facility were made. Continuous fields of 255 kG in a very small volume, 225 kG in a 1½-in. bore and 205 kG in a 2-in. bore are available. These are the highest continuous fields produced anywhere. More reliable superconducting magnets and high field, larger volume pulsed field magnets have also been developed. The Laboratory's research program in solid-state and low-temperature physics has improved understanding of the electrical, magnetic, optical and acoustic properties of matter. New and more sensitive techniques for magneto-optical studies such as electro-reflectance and piezo-reflectance and the use of laser sources have been developed and used to gain new information on the band structure of semiconductors. Studies of the new-type-II high-field superconductors by a variety of techniques have revealed the factors which limit the usefulness of these materials for high field magnets. The magnetic properties of many solids have been explored by high field magnetization apparatus giving temperatures down to three millidegrees above absolute zero. Theoretical studies of band structure, crystal field theory, superconductivity and other topics have been carried on in close conjunction with the experimental program. (auth)

42016 (UCID-15181) ALICE BASEBALL II PROPOSAL. Post, R. F.; Damm, C. C.; Foote, J. H. (California Univ., Livermore. Lawrence Radiation Lab.). Aug. 14, 1967. Contract W-7405-eng-48. 21p. Dep. CFSTI.

A general description is given of the Baseball II magnetic system. The magnetic field requirements and limitations of the systems are discussed. The overall performance of the system is discussed. (M.O.W.)

42017 MOTION OF TOROIDAL MAGNETIC SURFACES AND DIFFUSION OF A PLASMA RING. Bineau, M. (New York Univ., N. Y.). Phys. Fluids, 10: 2026-35(Sept, 1967).

The time derivative of the magnetic field can always be represented by a velocity field in a simply connected domain. However, in a toroidal domain the condition for such a representation with a single valued velocity is very stringent. The case considered here is that of initially nested magnetic surfaces in which a multivalued velocity is allowed provided that certain conditions are satisfied. These conditions imply that the component of the velocity normal to the magnetic surfaces is single valued. In this situation there is a convenient representation of the time derivative of the magnetic field. This representation can be applied to the description of resistive diffusion. (auth)

42018 COMPRESSION OF A RAREFIED PLASMA BY CONVERGING MAGNETIC MIRRORS. Bird, G. A. (Univ. of Sydney). Phys. Fluids, 10: 2049-53(Sept, 1967).

A solution is obtained for the temperature, density, total number, and energy of the particles trapped between magnetic mirrors which, at zero time, acquire a uniform velocity of convergence. It is assumed that collisions between particles may be neglected and that the collisions with the mirrors are adequately described by the guiding center theory. It is found that, for a given mirror strength and rate of convergence, there are mirror spacings at which the energy reaches a maximum and the temperature and density reach limiting values. Furthermore, there are optimum rates of convergence at which these maximum and limiting values are a maximum. During the early stages of compression at high rates of convergence, the temperature rises at a far greater rate than the square of the density. (auth)

42019 EXPERIMENTAL STUDY OF COLLISION-FREE SHOCK WAVES AND ANOMALOUS ELECTRON HEATING. Goldenbaum, George C. (Univ. of Maryland, College Park). Phys. Fluids, 10: 1897-1904(Sept. 1967).

Cylindrically converging magnetic compression waves have been observed propagating into a low density hydrogen plasma ($n_e = 3 \times 10^{14}$, $kT_e = 1.4$ eV) in a fast theta pinch discharge with the compressing field and initial field both parallel and antiparallel. For parallel fields, the waves are nonstationary in this experiment and cylindrical convergence effects cannot be ruled out. The thickness of the transition is greater than 1 cm which is less than the ion gyroradius and the ion mean free path for ions traveling with the wave front across the initial magnetic field. The electron heating rate (≈10 eV/nsec) and the transition thickness are both greater than one would expect for resistive heating with the Spitzer–Härm resistivity. In the case where the compressing field and the initial field are antiparallel, a wave flow develops which appears to be an almost plane and nearly stationary collision-free shock. For an initial field of −450 G the Alfvén Mach number is estimated between 4 and 9. The magnetic transition has a slowly rising front part (>1 cm) followed by a faster rising part ($l \simeq$ 3 mm). (auth)

42020 STATISTICAL THEORY OF THE DIFFUSION OF CHARGED PARTICLES. Ebeling, Werner (Univ., Rostock, Ger.). Beitr. Plasmaphys., 7: 11-22(1967). (In German).

A diffusion equation for a charged particle in an oscillating electric field is derived. The Liouville equation for the distribution function of the whole system consisting of the host fluid and the charged particle was used. In order to obtain the time evolution of the distribution function of the charged particle in the coordinate space, the technique of projection operators developed by Zwanzig was used. Under appropriate circumstances the correlation function may be computed by means of the Langevin–

Kirkwood equation. The relation between their theory and that obtained by Lebowitz and Resibois is discussed. It is further shown that at higher concentrations of charged particles the gradient of the concentration must be replaced by the gradient of the local osmotic pressure. The theory is applied to ambipolar diffusion. (auth)

42021 RESONANT DIFFUSION OF PLASMA ACROSS A MAGNETIC FIELD. Stix, Thomas H. (Princeton Univ., N. J.). Contract AT(30-1)-1238. Phys. Fluids, 10: 1601-14(Aug. 1967). (MATT-460).

The particle transport associated with low-frequency waves is calculated for a nonuniform plasma immersed in a magnetic field. Electrons and ions in a model plasma obey E × B drift across B, and are accelerated by E_z along B. Their distribution function is given by the solution of the kinetic drift equation. The first-order density perturbation, $n^{(1)}$, is made consistent with the first-order electric field, E, and the flux $cE_y n^{(1)}/B$ is averaged over large periods in t and z. The method of calculation is equivalent to quasi-linear theory and yields the following results: the process for transport may be described as a diffusion in (x, v_z) phase space which, for each Fourier component, is restricted to resonant particles (i.e., particles moving along B = ẑB with zero-order velocity $v_z = \omega/k_z$) and to lines in (x, v_z) space with the slope $(qB/mc)(\tilde{E}_z/\tilde{E}_y)$—hence "resonant diffusion"; the transport is ambipolar, the direction of transport can be parallel or anti-parallel not only to $-dn/dx$, but also to $-\partial f_0(x, \omega/k_z)/\partial x$, leading to situations of "pump-out," "normal pump-in" or "anomalous pump-in"; using a zero-order velocity distribution in which the density, parallel flow velocity, and temperature may be functions of x, it is possible to balance destabilizing and damping forces against each other to create states of marginal stability—these states, for which small-amplitude theory is valid, still show pump-in or pump-out. As a final result, it is found that the wave-energy conservation equation can be restated in a manner which relates cross-B particle fluxes to the product of instability growth rate and wave energy density. (auth)

42022 TEMPORARY TRAPPING OF CHARGED PARTICLES IN A STATIC MAGNETIC BOTTLE. Hubert, Pierre; Touche, Jacques (EURATOM-CEA., Fontenay-aux-Roses, France). Phys. Fluids, 10: 1676-84(Aug. 1967).

A temporary trapping device which combines the resonant perturbation method (Sinelnikov method) and the method of injection through a saddle point in the Störmer potential configuration is discussed theoretically and experimental results are presented. A temporary trapping duration corresponding to 450 transits on the average for the whole beam has been obtained in agreement with a theoretical prediction which assumes a uniform density in all the phase space available inside the bottle. (auth)

42023 HOT-ELECTRON PLASMA CONFINEMENT IN MAGNETIC FIELDS WITH COMPENSATING CURVATURE. Hartman, Charles W. (Univ. of California, Livermore). Phys. Fluids, 10: 1685-8(Aug. 1967). (UCRL-70119).

Loss of plasma across B is observed when the average field curvature is destabilizing in the hydromagnetic sense. Under stable curvature conditions loss across B is suppressed and enhanced end-loss bursts appear. (auth)

42024 BALL LIGHTNING. Barry, J. Dale (Univ. of California, Los Angeles). J. Atmos. Terrest. Phys., 29: 1095-1101 (Sept. 1967).

The results of an extensive survey of ball lightning observations which were reported during the last 300 yr are presented. A statistical description of the phenomenon in terms of its properties and characteristics was obtained. The description is discussed and various relations between the properties and characteristics of the phenomenon are established. In addition, several properties previously attributed to ball lightning are shown to be erroneous. (auth)

42025 CHARGE-CARRIER LOSSES IN A WEAKLY IONIZED STATIONARY DIRECT-CURRENT PLASMA IN A TOROIDAL MAGNETIC FIELD. Karger, F. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Z. Naturforsch., 22a: 1039-57(July 1967). (In German).

For the particle losses of a weakly ionized plasma which result from the torus drift in a curved magnetic field, an expression is derived which is valid for certain parameters of the positive column of a gas discharge. To check this theory the "AMBIPOL" device was built. With this device it was possible to determine simultaneously the losses both in the toroidal and in the linear magnetic field by measuring the longitudinal electric field strength. As theory predicts, with growing magnetic field strength a weaker decrease of the longitudinal electric field was observed in the toroidal part of the discharge as compared to the linear part. The measured values of the relative electric field strength, however, exceed the theoretical limit, although the measurements of the electric field in the straight part and the measurements of the particle density and of the electron temperature in the curved part are consistent with theory. Moreover, contrary to the expectations, the onset of the Kadomtsev instability occurs at lower critical magnetic fields in the toroidal part than in the straight part. Several possible explanations are discussed. (auth)

42026 OPTICS OF CIRCULAR TUBES USED FOR PLASMA CONFINEMENT. Stokes, A. D. (Univ. of Sydney). J. Opt. Soc. Amer., 57: 1100-5(Sept. 1967).

The radiance distribution of a circularly symmetric plasma is shown to be free of distortion when viewed at right angles to the axis of a transparent cylindrical enclosure. The enclosure may consist of a number of concentric media of differing refractive index and, provided the system remains transparent, may be arbitrarily thick. The image radiance distribution may however be selectively attenuated if either the plasma itself, or the enclosure, absorb part of the light flux. Relations are given connecting the object and image distributions under these conditions. (auth)

Diagnostics of Plasma

Refer also to abstract 41787.

42027 (AD-647835) PLASMA DENSITY MEASUREMENTS WITH ENERGETIC BEAMS. Final Report, December 1, 1965-November 30, 1966. Report No. Scientific-2. Hickok, R. L.; Jobes, F. C.; Marshall, J. F.; Duncan, S. L. (Mobil Oil Corp., Princeton, N. J. Central Research Div. Lab.). Jan. 1967. Contract AF49(638)-1500. 55p. (AFOSR-67-0611). CFSTI.

A technique is described for using the collisional dissociation of an energetic molecular ion beam to measure the relative density of a magnetically confined plasma with a three dimensional spatial resolution of 0.005 cc. The ultimate time resolution obtainable with this technique is of the order of $10^7/(\text{NI})$ where N is the density of charged particles per cc. Time resolution of the present measurements were limited to $10^{10}/(\text{NI})$ by the data collection system. (auth)

42028 (AD-647895) THERMAL DISTRIBUTION AND CONDUCTIVITY OF ELECTRONS IN ARGON MOLECULAR GAS MIXTURES. Final Scientific Report. Constantin, A.; Hamm, J. J.; Pointu, A. M.; Rioux, R. (Paris Univ., Orsay (France). Laboratoire de Physique des Plasmas). 1966. Contract AF61(052)-727. 47p. (AFCRL-66-842). CFSTI.

Different parameters (as drift velocity in a dc electric field, or ratio of odd harmonics in an ac electric field) of a weakly ionized gas (argon) are computed in two cases using respectively the Maxwell function and the Margenau function as the electric energy distribution function. A discussion is given about the conditions of validity of such computations and the relative importance of the different collision processes especially between e-e collisions, and elastic e-atom collisions (effects of H_2 impurities are taken into account). (auth)

42029 (ARL-67-0062) RESEARCH ON PLASMA DIAGNOSTIC METHODS FOR HIGH TEMPERATURE PLASMA RESEARCH. Final Report. Dougal, A. A.; Friedrich, O. M. Jr.; Hagler, M. O.; Mayhall, D. J.; Roberts, H. N.; Weigl, F. (Texas Univ., Austin. Plasma Dynamics Research Lab.). Mar. 1967. Contract AF33(615)-3124. 100p. CFSTI.

A new experimental arrangement of the infrared maser-interferometer-detector combination employed to investigate dynamical gaseous plasmas and narrow, rapidly moving cylindrical detached shocks in a 30-kJ theta pinch was conceived, fabricated, and tested. This maser-interferometer-detector system has markedly improved frequency response. Earlier experimental data indicated that the upper limit on the frequency response of the electron density measuring system was limited by the InAs detectors rather than the maser. A careful investigation of the detached shock produced in the theta pinch requires time resolution of a few tens of nanoseconds. The recent interference data obtained with this new arrangement shows that the frequency response is limited by the detectors. New InAs detectors with smaller diameter and improved frequency response and surface responsivity are utilized. When employed with a cone channel condenser constructed of highly reflecting silver and placed in front of the detector to gather the incident radiation, useful interferometry data up to at least 30 Mc should be possible, even with small deflections of the maser beam. Because of its usefulness in determining the electron density from laser interferometry data, an expression for the laser resonator energy density as a function of the second resonator length was derived, under the assumption of dielectric mirrors. This expression was specialized for the He-Ne 3.39 μ laser by assigning approximate values to the various laser rate coefficients. The varia-

tion of the energy density with the second resonator mirror length for various combinations of the second resonator mirror reflectivities was obtained in the form of curves. The behavior of the energy density was found to agree with general predictions based on a consideration of the equivalent reflectivity of the second resonator. The expression for the energy density was within 20% of experimental data in which the second resonator length was varied. The theoretical curves have been compared with interferometer data from the theta pinch electron density decay and are found to agree less well. There appears to be an effective reduction of the second resonator mirror reflectivities when the second resonator contains a theta pinch plasma. This reduction of reflectivities is aggravated when a bias magnetic field is applied to the theta pinch plasma. A Fabry–Perot interferometer in which the plane mirrors of infinite extent are prefaced by Brewster windows, plane electromagnetic waves propagate along the z axis through a lasing medium immersed in a steady state magnetic field was considered. The effect of the magnetic field on resonator tuning, on critical gain requirements, and on the polarization of the laser output beam were investigated. Experimental results agree well with the maximum angle of rotation predicted for relatively small magnetic fields. The advent of the giant pulse ruby laser as an extremely powerful energy source has provided the plasma researcher with a means of producing ultrapure plasmas in which electron densities may range as high as 10^{21} electrons/cm^3. A giant pulse ruby laser illuminated Mach–Zehnder interferometer is employed to study laser induced discharges in air at atmospheric pressure. The theory of operation of a Mach–Zehnder interferometer is discussed briefly before a discussion is presented showing the relationship between the refractive index of a plasma and the number densities of free electrons, ions, and neutrals. The results of an interferometric study of the first 2 msec of development of the laser induced discharge in air at atmospheric pressure are presented and interpreted. Correlative data are also presented showing the lifetime of the discharge to approach 40 msec though significant ionization is probably not present after 10 to 15 μ sec. When a fraction of a joule (or more) of energy is released in a gas, strong shocks are formed. Strong blast wave theory was employed to investigate the dynamics of gaseous plasmas produced when a giant-pulse ruby laser was focused in gases initially at 1 to 2000 atmospheres. The position of the luminous front associated with the shock wave which is produced was observed with a high-speed Kerr cell photography system. During the rapid radial expansion of the shock, the measured position vs time of the leading luminous edge normally agrees to within 10% of the predicted position. Employing an optical Mach–Zehnder interferometer illuminated by a 30-MW giant-pulse ruby laser, strong shocks produced in air at STP with a second, 175-MW giant-pulse ruby laser were investigated. Photographs show the formation and radial expansion of the strong shocks produced. Initially the shock is elongated in the direction of the laser beam, but as time progresses (3 to 6 μs) the shock front becomes more circular (spherical). The position of the shock as a function of time agrees with calculations based on strong blast wave theory. Small piezoelectric, pressure-sensitive probes were employed to investigate the shock produced in air at STP. Relatively strong shocks are observed at radii in excess of 50 cm. Initial measurements indicate that the pressure fronts are spherical for radii larger than 2 cm. (auth)

42030 THE INFLUENCE OF ELEMENTS WITH LOW IONIZATION POTENTIALS ON THE RADIAL DISTRIBUTION OF TEMPERATURE IN THE DC ARC PLASMA. Vukanovic, D. D. Rad. Zavoda Fiz., 5: 5-10(1965). (In Bulgarian).

The radial distribution of temperature was investigated in a dc arc burning freely under conditions applied in the usual spectrochemical practice. It was stated that in the plasma under study there exists a region of constant temperature in the central section of the arc. The presence of large amounts of elements having low ionization potentials (Li and Ca) is assumed to contribute to the shape of the observed radial temperature profile. (auth)

42031 EFFECTIVE OHM'S LAW IN A PARTIALLY IONIZED PLASMA WITH ELECTRON DENSITY FLUCTUATIONS. Louis, Jean F. (Avco Everett Research Lab., Mass). Phys. Fluids, 10: 2062-64(Sept. 1967).

Theories and experiments show that instabilities exist in plasma operating at Hall coefficient larger than one. An effective Ohm's law applicable to plasma with homogeneous electron density fluctuations appears to explain available experimental results. (auth)

42032 AERODYNAMIC STUDY OF AN ARGON PLASMA. Henderson, Dale B. (Cornell Univ., Ithaca, N. Y.). Phys. Fluids, 10: 1962-7(Sept. 1967).

An rf argon plasma generator has been built in combination with a ballistic range. Spheres are photographed in free flight (at about 2 km/sec) through the plasma with an imbedded magnetic field using an image converter camera. From a series of such photographs the standoff distance of the bow shock wave is measured as a function of velocity. From this function the state of the neutral gas is deduced; from analysis of spectral data, the state of the electron gas is deduced. A model for the plasma is constructed from these data using a kinetic-theory approach. This model features a neutral gas temperature which is uniform over most of the plasma and an electron temperature which is elevated by 900°K in the outer skin depth. This model is not in agreement with previous studies of similar plasmas, these previous studies lacking any direct knowledge of the neutral gas state. (auth)

42033 HARMONIC GENERATION AND TURBULENCELIKE SPECTRUM IN A BEAM–PLASMA INTERACTION. Apel, J. R. (Johns Hopkins Univ., Silver Spring, Md.). Phys. Rev. Lett., 19: 744-6(Sept. 25, 1967).

The apparatus consists of a steady-state 25-eV plasma formed by a P.I.G. discharge and a repetitively pulsed, 400-V electron gun; both are immersed in a uniform magnetic field of 400 G. The uhf signals which are received on an E_r-sensitive, axially traveling probe located at the edge of the discharge column, are bandpass filtered, analyzed on a Hewlett–Packard 8551 spectrum analyzer, and then detected and smoothed using a lock-in amplifier synchronized to the pulse repetition frequency. The power spectral densities are plotted and discussed. (M.H.R.)

42034 INTERFEROMETRIC DETERMINATION OF ELECTRON DENSITY IN AN ELECTROMAGNETIC SHOCK TUBE UNDER APPLICATION OF A GUIDING WAVE. Dietz, K.-J. (Univ., Goettingen, Ger.). Z. Angew. Phys., 23: 228-35(1967). (In German).

The electron density between the shock front and the discharge plasma in an electromagnetic shock tube was investigated by using an interferometer technique, which operated with guided waves. To guide the waves dielectric wires were used. A spatial resolution of 1.6 mm could be reached. The measurements were carried out at velocities of the shock front ranging from 3.0 to 4.5 mm/μsec in air. Electron densities between 10^{11} and 10^{13} cm^{-3} were found. The increase of the electron density behind the shock front as well as the distance of the maximum of the electron density from the shock front were related to the velocity of the shock front and the distance of the test region from the discharge electrodes. Within the experimental limits the maximum of the electron density behind the shock front was found dependent on the shock front velocity but was independent of the distance of the test region from the discharge electrodes. (auth)

42035 DETERMINATION OF AVERAGE PLASMA CONDUCTIVITY BY rf PROBES. Ciampi, M.; Talini, N. (CAMEN, Pisa, Italy). J. Appl. Phys., 38: 3771-6(Aug. 1967).

Study of determination of the spatial average plasma conductivity by a radio-frequency probe is tackled for a cylindrical plasma assumed radially inhomogeneous. The real and imaginary part of the probe impedance vs the probing frequency are found numerically for inhomogeneous plasmas with conductivity profiles of the type $\sigma(\rho) = \sigma_{max}(1 - m\rho^n)$. With such an analysis only two independent average conductivities are found, both at low frequency. The analytical form of the average conductivities is obtained, comparing, in a low-frequency approximation, the tested inhomogeneous medium with a fictitious homogeneous one for which the real or imaginary part of the probe impedance varies in the same way. As a result of a measurement of the rf energy dissipation in the medium (effected by evaluating the probe Q-factor), the average conductivity is $\sigma^* = (4/R^4)\int_0^R \sigma(r) r^3 dr$; the average conductivity becomes $\sigma^2_{**} = \frac{3}{4}[(4/R^4)\int_0^R \sigma(r) r^3 dr]^2 + (3/2R^6)\int_0^R r^5 dr[(4/r^4)\int_0^r \sigma(r) r^3 dr]^2$ in case of a measurement of the inductance variation. An application of the method is carried out in a flow facility plasma jet; with Q-factor measurements from 0.5 to 1.5 MHz, average conductivity values from 75 to 100 mho/m are obtained. The probe is calibrated with electrolytic solutions (H_2SO_4) of standard conductivity. (auth)

42036 ELECTRICAL CONDUCTIVITY OF A FULLY IONIZED PLASMA. Niu, Keishiro (Osaka Univ., Japan). Phys. Fluids, 10: 1857-8(Aug. 1967).

Using a Druyvesteyn distribution for the electrons and a Maxwellian distribution for the ions, the electrical conductivity of a fully ionized plasma is derived. (auth)

42037 QUASI-OPTIC IMAGING RESONATOR FOR PLASMA DIAGNOSTICS. Auston, D. H. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.) Trans. Aerospace Electron. Syst., AES-3: 441-6(May 1967).

The theory and operation of a new millimeter-wave resonant interferometer are described. It has the unique capability of measuring the spatial distribution of electrons in a low-density transient plasma column. The fundamental property of the resonator is that it is multiply degenerate. Its geometry consists of 4 spherical mirrors arranged in a confocal ring configuration

such that the transverse modes are simultaneously resonant. Energy is coupled into and out of the resonator by thin dielectric film beam splitters. When perturbed, it was found that the resonant frequency of the system depended on the point at which the field was measured and this dependence was directly related to the geometry of the perturbation. The results of a theoretical analysis of the perturbation of the resonator are presented and preliminary experimental measurements of a 4-mm system are discussed. It is concluded that use of multiply degenerate resonators to derive spatial information about a perturbing medium is sound from a theoretical point of view and should prove to be a useful technique for diagnostics of transient plasmas. However, further work is required to reduce the effects of aberrations so that the technique may be extended to shorter wavelengths. (BBB)

42038 DOUBLE-PROBE METHOD WITH A STEPWISE HIGH-FREQUENCY PULSED VOLTAGE. Terao, Kunio; Nishida, Yukihiro; Sato, Tadashi (Yokohama National Univ., Japan). Jap. J. Appl. Phys., 6: 1154-62(Oct. 1967).

In order to measure an unstable plasma, a double-probe method with a high-frequency multistep pulsed voltage composed of square waves was developed and applied to measure detonation waves. Corresponding to the 6 probe potentials given by this composite pulse, the probe currents in detonation waves were measured in an oscillogram as 6 curves for a sufficiently slow sweeping time. From this oscillogram a probe characteristic at an arbitrary time and then the electron temperature, ion density, etc. continuously during the time that the detonation waves passed by the probe could be obtained. By this method an unstable plasma can be measured very rapidly, for example in 10^{-6} sec for a plasma with $10^{12}/cm^3$ electron density, and continuously for relatively long times from about 100 μsec to 20 msec. (auth)

42039 SPECTRAL DIAGNOSTICS OF A UNIPOLAR HIGH-FREQUENCY DISCHARGE EXCITED IN NITROGEN AND ARGON AT PRESSURES FROM 1 TO 12 ATM. Janca, J. (Purkyne Univ., Brno). Czech. J. Phys., 17: 761-72(1967).

By methods of spectral diagnostics, the temperature of neutral gas and the electron temperature and density have been determined in the channel of a unipolar high-frequency discharge excited at very high pressures. In nitrogen the hf discharge was excited at pressures of 1 to 5 atm, in argon at pressures of 1 to 12 atm. In the discharge excited in argon, the electron temperature does not change with increasing pressure and is $T_e = (6 \text{ to } 7) \times 10^3$ °K; the electron density increases with increasing pressure. It can be demonstrated that the electron velocity distribution is given by a Maxwellian distribution function although the plasma of a unipolar high-frequency discharge is nonisothermal. (auth)

42040 INVESTIGATION OF A CESIUM PLASMA DIODE USING AN ELECTRON BEAM PROBING TECHNIQUE. Ott, Werner (Institut fuer Plasmaphysik GmbH, Garching, Ger.). Z. Naturforsch., 22a: 1057-67(July 1967).

The plasma in a plane cesium diode with a hot emitter and a cold collector was investigated experimentally with a ribbon-shaped electron beam. The ribbon beam is projected through the diode at an angle of 45 degrees to its axis and allowed to strike a fluorescent screen. Variations in the axial electric field of the diode cause the ribbon beam to be distorted. The image of the distorted beam as seen on the fluorescent screen then constitutes a plot of the axial electric field along the axis of the diode. The field plots so obtained are compared with a theory in which the collisions of the charge carriers are neglected. By means of this comparison it is possible to evaluate the neutralization parameter, the plasma density, and an average drift energy of the charge carriers. The results show that the theory correctly describes the different modes of the potential distribution and especially the transitions between modes of operation as long as the diode is free of oscillations. The stability of the different possible static potential distributions was also investigated. It was found experimentally that the system is unstable if the electron emission is less than the ion emission and the collector potential is positive. (auth)

42041 SPECTROSCOPIC MEASUREMENT OF THE TEMPORAL COURSE OF THE RADIAL DENSITY AND TEMPERATURE DISTRIBUTION IN A HYDROGEN SPARK. Tholl, H. (Univ., Hamburg). Z. Naturforsch., 22a: 1068-88(July 1967). (In German).

The temporal variation of the radial distribution of electron density and temperature in an oscillating spark in H_2 at $p_0 = 460$ torr, initiated by the streamer process, was investigated in order to obtain an insight into the dynamic behavior of the spark plasma channel. At the beginning of the channel expansion the electron densities measured from the Stark effect broadening of H_β amount to $\sim 10^{18}$ cm^{-3}, and after the end of expansion $\sim 10^{17}$ cm^{-3}. The measurements gave a maximum axial temperature of 52,000°K at the maximum in current of the first half period ($i_{max} = 1800$ A). The pressure increase in the plasma channel at the beginning of its expansion was calculated from the measured density and temperature values to be $p/p_0 \sim 20$. By the end of the first half period in current this pressure ratio has already sunk to $p/p_0 \sim 3$. The spark channel achieves a maximum specific conductivity of $\eta = 520$ $(\Omega \text{ cm})^{-1}$ at the maximum in current of the first half period and reaches its maximum conductance of $G = 6\Omega^{-1}$ after the end of the third half period of current. The energy supplied to the spark is expended in approximately equal proportions for the ionization, heating and expansion of the spark plasma. The temporal and radial variation of the total density within the heated plasma channel and in the surrounding shock disturbed region is given and an interpretation of the so-called "envelope" of the channel is put forward. (auth)

42042 LASER INTERFEROMETRIC MEASUREMENTS OF ELECTRON DENSITY IN AN ARC PLASMA. Hearne, K. R.; Konjevic, N. (Univ. of Liverpool). Z. Phys., 204: 443-55 (1967).

The application of a laser interferometric technique to arc discharges operating at atmospheric pressure is described. The limitations of this method are discussed in detail. Results are given for the axial electron density in an argon arc for a tube 5 mm in diameter over a current range of 30 to 75 A. The decay of the electron density following rapid arc interruption is also given. It is shown that the time constant of the conductance decay, which can be derived from the preceding measurements, is in very good agreement with experimental values determined directly. (auth)

42043 NEGATIVE ABSORPTION IN THE BANDS OF THE MOLECULAR ION OF NITROGEN IN A GLOW DISCHARGE. Elizar'eva, V. N.; Obukhov, V. I.; Murav'ev, I. I.; Mel'chenko, V. S. (Siberian Physical-Technical Inst., Tomsk, USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 4, 159-60(1967). (In Russian).

Negative absorption was observed in a dc glow discharge in nitrogen gas across the vibrational transitions 0 to 0 λ3914.4 Å and 0 to 1 λ4278.1 Å. The absorption measurement involving a single mirror was employed for this purpose. The authors measured the ratio of the absorption band intensities during discharge in the presence of the mirror (I_m) and in its absence (I_{nm}). The plane mirror with the electromagnetic shutter in front of it is connected beyond the electrode at the end of the discharge tube perpendicularly to its axis. The diameter of the working portion of the discharge tube is 7 mm, with the distance between the electrodes 165 mm. The discharge was excited by a dc source at 1000 to 1300 v (currents 30 to 80 mamp). The nitrogen pressure was kept between 0.5 and 2.5 mm Hg. The proof of negative absorption was assumed to depend on the inequality $I_m/I_{nm} > (I_m/I_{nm})_0$, the right-hand term pertaining to a line subject to reabsorption. The magnitude of $(I_m/I_{nm})_0$ measured in five bands (0-0, 0-1, 0-2, 1-3, and 1-4) of the second positive band system of N_2 was 1.26 ± 0.04, accurate to 99%, while I_m/I_{nm} was 1.56 ± 0.08 measured with the same accuracy for the bands 0-0 and 0-1 of the first negative band system of N_2^+. (ATD)

42044 CALCULATION OF ELECTRON DENSITY FROM THE INTENSITY RATIO OF SPECTRAL LINES OF A GIVEN ION. Suckewer, S. (Inst. of Nuclear Research, Swierk, Poland). Phys. Lett., 25A: 284-5(Aug. 14, 1967).

It is shown that from the relative intensities of two chosen lines of a given ion it is possible to determine the electron density of nonthermal plasmas. (auth)

42045 MODELING ERRORS IN MICROWAVE PLASMA DIAGNOSTICS EMPLOYING THE REFLECTION COEFFICEINT. Kinney, Ralph A. (Univ. of Florida, Gainesville). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-14: No. 4, 29-37(Aug. 1967).

The use of the complex reflection coefficient, R, at microwave frequencies as a plasma diagnostic tool in the high electron density range (10^{12} electrons/cm^3) has been reported by several authors. A common assumption is that at microwave frequencies the boundary between free space and a stationary plasma is best described as a step function in electron density. Actually, many practical boundaries consist of a finite-width region wherein the electron density has a finite gradient. The complex reflection coefficient is derived for the finite width boundary and comparisons are made with an assumed sharp boundary. It is shown that improper modeling of the plasma boundary can result in significant error in electron density measurements when R is used as a diagnostic tool. (auth)

Kinetics of Plasma

42046 (AD-645745) PARAMETRIC COUPLING BETWEEN TRANSVERSE ELECTROMAGNETIC AND LONGITUDINAL ELEC-

TRON WAVES. Report No. Scientific 9. Sjolund, A.; Stenflo, L. (Kungliga Tekniska Hogskolan, Stockholm (Sweden)). Oct. 30, 1966. Contract AF61(052)-895. 16p. (RADC-TR-67-33). CFSTI.

Parametric coupling between transverse electromagnetic and electron waves in a plasma was studied by means of coupled mode theory. The coupling coefficients was determined. Two examples of parametric coupling were considered. One is the same as treated by Montgomery, and the other results in parametric amplification. The growth rate was calculated. (auth)

42047 (ARL-67-0119) ELECTRIC ARC DISCHARGES IN TRANSVERSE MAGNETIC FIELDS. PART I. Schrade, Herbert O. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). June 1967. 106p. CFSTI.

The dynamic behavior of electric arc discharge columns, which are subjected to transverse external magnetic fields, was studied through an analysis of all the forces acting normal to a segment of the arc column. This analysis led to an explanation of "magnetic arc pumping" which was found to be the cause of arc retrograde motion as well as the discontinuous motion of electrode attachment points. It is shown that a gasdynamic force is generated through the combined action of the self-induced magnetic field of a current-carrying plasma and of a superimposed external magnetic field. (M.O.W.)

42048 (IPP-6/58) ZUR RELATIVISTISCHEN NICHTLINEAREN WECHSELWIRKUNG KALTER PLASMEN MIT ELEKTROMAGNETISCHEN WELLEN. (On the Relativistic Non-Linear Interaction of Cold Plasmas With Electromagnetic Waves). Luenow, Werner (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). July 1967. 71p. (In German). Dep.

The behavior of a fully ionized plasma composed of one type of atom and subjected mainly to electromagnetic forces (waves) is treated analytically. Forces due to the stress (pressure) tensors of the ions and electrons, to gravitation and to ion-electron interactions, as opposed to electromagnetic forces, are ignored. The mean thermal particle velocities have to be sufficiently small compared with the phase velocities of longitudinal plasma waves (Landau damping). The problem is described by relativistic (convariant) field equations and equations of motion. The general fundamental equations lead to a special system of equations yielding wave solutions in which all partial waves have the same space-time constant phase velocity. (auth)

42049 (LA-3735) CESIUM MAGNETOHYDRODYNAMIC COAXIAL ARC JET. Blackstock, A. W.; Fradkin, D. B.; Roehling, D. J.; Stratton, T. F. (Los Alamos Scientific Lab., N. Mex.). Jan. 1967. Contract W-7405-eng-36. 20p. Dep. CFSTI.

A cesium-fueled magnetohydrodynamic arc jet was operated between 4 and 12 kW at magnetic field strengths up to 1000 G. Electrostatic probe, spectroscopic, and microwave measurements were made on the exhaust beam. Beam momentum was determined from the deflection of a downstream sieve. The magnitude and position of Hall currents was determined using magnetic loop pickup coils. The overall arc voltage is a linear function of applied axial magnetic field strength. The thrust is a linear function of the product of the arc current and applied axial magnetic field strength, and is of a magnitude too great to be produced by the measured Hall currents. A partial theory is developed that describes the functional dependence of the arc voltage and thrust. Data are presented that show mass entrainment was present and that when the arc is operated with mass entrainment the exhaust velocity is predicted by the Alfvén "critical velocity." (auth)

42050 (LA-3736) MACROSCOPIC ANALYSIS OF MAGNETOPLASMADYNAMIC ARC JETS. Black, Neville A.; Fradkin, David B. (Los Alamos Scientific Lab., N. Mex.). July 1967. Contract W-7405-eng-36. 12p. Dep. CFSTI.

Scaling laws for coaxial applied-field and self-field magnetoplasmadynamic arc jets are obtained by dimensional analysis. The electromagnetic stress tensor is used to obtain formulas for the aggregate effect of $\vec{j} \times \vec{B}$ forces, both thrust and torque, throughout the discharge volume, in terms of the magnetic field over a bounding surface. A simple rotating plasma model for applied-field accelerators is developed. The present state of self-field accelerator research is reviewed. Efficiencies of idealized linear accelerators are compared with the characteristics of the corresponding coaxial devices. (auth)

42051 (NP-16945, pp 139-42) COUPLING OF TRANSVERSE AND LONGITUDINAL WAVES BELOW THE SECOND ELECTRON CYCLOTRON HARMONIC. Kuehl, H. H.; Stewart, G. E. (University of Southern California, Los Angeles. Electronic Sciences Lab.).

Using Pearson's current density in Maxwell's equations, the coupling is considered of a transverse wave with propagation direction and electric field perpendicular to a static magnetic field, incident on a nonuniform plasma half space. (M.O.W.)

42052 (NP-16945, pp 142-6) EXPERIMENTAL STUDY OF COUPLING TO CYCLOTRON HARMONIC RESONANCES. Stewart, G. E.; Kuehl, H. H. (University of Southern California, Los Angeles. Electronic Sciences Lab.).

The emission of anomalously high noise from plasma in the vicinity of harmonics of the electron cyclotron frequency is briefly discussed in terms of radiations from cyclotron harmonic waves. (M.O.W.)

42053 EXCITATION OF OSCILLATIONS IN DECAY INSTABILITY OF STEADY-STATE WAVES IN A PLASMA. Karplyuk, K. S.; Oraevskii, V. N. (Kiev State Univ.). JETP Lett. (USSR) (Engl. Transl.), 5: 365-7(June 15, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 5: 451-3(June 15, 1967).

It is shown that decay instability can give rise to violet satellites that grow with increments proportional to the amplitude of the initial wave. In addition, it is shown that under definite conditions the decay instability does not arise even upon satisfaction of the decay conditions $\omega_k = \omega'_k + \omega''_k$, $k''' = k + k''$. (M.O.W.)

42054 LARGE AMPLITUDE ELECTROTHERMAL WAVES IN A NONEQUILIBRIUM PLASMA. Zukoski, Edward E.; Gilpin, Robert R. (Calif. Inst. of Technology, Pasadena). Phys. Fluids, 10: 1974-7(Sept. 1967).

Steady, one-dimensional current streamers have been observed in a nonequilibrium plasma subjected to crossed E and B fields. Their half-width and amplitude agree with a nonlinear model of electrothermal waves. (auth)

42055 WAVE PROPAGATON IN A PARTLY IONIZED GAS. II. Tanenbaum, B. Samuel; Meskan, David A. (Case Inst. of Technology, Cleveland). Phys. Fluids, 10: 1977-80(Sept. 1967).

Simple dispersion relations for longitudinal waves are derived for plasmas satisfying the hydrodynamic equations subject to the conditions: $10^{10} < N_{n0} < 10^{16}$ cm^{-3}; $10^9 < N_{e0} < 10^{14}$ cm^{-3}; $T_e \gg T_{i,s}$; $T_{i,n} < 10^4$ °K $< T_e$. In addition, the exact solutions to the dispersion equation are obtained (for arbitrary number densities and temperatures) in the low-frequency limit, and the damping factor for the low-frequency acoustic mode is calculated. (auth)

42056 VOLUME FORCES IN PLASMAS. Leiby, C. C. Jr. (Cambridge Research Labs., Bedford, Mass.); Oskam, H. J. Phys. Fluids, 10: 1992-6(Sept. 1967).

A formula is derived for the force exerted by charged particles on neutral particles in a gaseous discharge. It is shown that (a) the discussions of Langmuir and Druyvesteyn with respect to the reaction force on the neutral gas particles resulting from the net rate of momentum transfer by the charged particles to the wall of the discharge tube are incomplete and (b) the expression for the force postulated by Leiby is a limiting case of a more general form of the force equation. The calculations also show that the presence of discharge container walls is not required for the existence of volume forces in contrast with the theories presented by Langmuir and Druyvesteyn. (auth)

42057 DOPPLER MEASUREMENTS OF THE KINETIC ENERGIES PRODUCED IN RADIO-FREQUENCY PLASMOIDS. Trimmier, J. R.; Miller, A. (New Mexico State Univ., Las Cruces). Phys. Fluids, 10: 1997-2001(Sept. 1967).

Measurements of the Doppler widths of the emission lines from radio-frequency plasmoids show that the ions and atoms have much higher kinetic energies in a discharge which forms dark-ring radio-frequency plasmoids than in a discharge which does not form such plasmoids. The values of the translational kinetic energy are shown to depend on the peak rf excitation voltage and the system gas pressure. These experimental results seem to support the potential-well model of plasmoid formation at low pressure and at low rf excitation voltage. (auth)

42058 PLASMA WAVE REFLECTION IN SLOWLY VARYING MEDIA. Berk, H. L. (Univ. of California, San Diego, La Jolla); Horton, C. W.; Rosenbluth, M. N.; Sudan, R. N. Phys. Fluids, 10: 2003-16(Sept. 1967).

Two mathematical formalisms are presented to describe wave reflection in a slowly varying spatially inhomogeneous thermal plasma described by the Vlasov equation. It is found that the transmitted wave, which is the Wentzel-Kramer-Brillouin solution, and the reflected wave, can be expressed in terms of the local dielectric properties of the medium. In a numerical example, it is shown that the intrinsic thermal properties of the plasma can supply reflection mechanisms that compete with the reflection coefficient predicted when the plasma is described by fluid equations. (auth)

42059 SHIELDING IN ANISOTROPIC PLASMAS. Joyce, Glenn; Montgomery, David (Univ. of Iowa, Iowa City). Phys. Fluids, 10: 2017-20(Sept. 1967).

The shielding of charges by spatially uniform electron plasmas with nonzero streaming is considered. Both shielding clouds surrounding "test charges" and density–density correlation functions are calculated. The result emerges that the shielding is not of the exponential Debye type, but is of much longer range, falling off in general as some inverse power of the distance. (auth)

42060 NONLINEAR ASYMPTOTIC ANALYSIS OF THE POSITIVE COLUMN. Friedman, Herbert W. (Polytechnic Inst. of Brooklyn, Farmingdale, N. Y.). Phys. Fluids, 10: 2053-61 (Sept. 1967).

The positive column of a slightly ionized gas discharge confined by cold, insulating walls is described by a set of nonlinear fluid equations. The inertia, space charge, and collision terms are retained. A zeroth-order solution uniformly convergent to the exact solution in both plasma and sheath regions is derived using asymptotic boundary-layer analysis. The value of potential at the wall is calculated by means of a kinetic model. It is found that the density at the wall can be a significant fraction of the value at the center and that it vanishes only in the low electron temperature limit. The original Bohm criterion is recovered as a necessary condition for sheath stability and is interpreted to mean that the ambipolar sound speed (1) asymptotically separates the plasma from the sheath, and (2) is the maximum ambipolar diffusion velocity. (auth)

42061 CORRELATION FUNCTIONS AND SCATTERING OF ELECTROMAGNETIC WAVES BY INHOMOGENEOUS AND NONSTATIONARY PLASMAS. Weinstock, Jerome (Inst. for Telecommunication Sciences and Aeronomy, Boulder, Colo.). Phys. Fluids, 10: 2065-72(Sept. 1967).

A rigorous formalism is given for interpreting the weak (Born) scattering of em waves by macroscopically inhomogeneous and nonstationary plasmas (plasmas whose macroscopic electron density varies within the scattering volume). This formalism does not resort to the heuristic, though useful, (coherent) assumption $\langle|n(k,\omega)|^2\rangle = |\langle n(k,\omega)\rangle|^2$, where $n(k,\omega)$ and $\langle n(k,\omega)\rangle$ denote the (Fourier transformed) microscopic and macroscopic electron density, respectively. Rather, criteria for the validity of this assumption are determined. Generally, it is valid for only isolated regions of k and ω space—depending on the specific nature of $\langle n(k,\omega)\rangle$. The derivation is based on the theorem relating space–time correlation functions to one-particle distribution functions. Correlation function and scattering divide into coherent (nonlinear) and incoherent parts. The coherent part $|\langle n(k,\omega)\rangle|^2$, is due to macroscopic density variations. The incoherent part is due to (microscopic) fluctuations about the macroscopically varying density and is determined by solutions of the linearized Vlasov equation with space–time varying background. Examples are given for plasmas with time varying Gaussian density profiles, damped oscillations, and undamped oscillations. (auth)

42062 POSSIBLE DEFINITION OF ENTROPY FOR WEAK TURBULENCE IN PLASMAS. Nakayama, Toshio (Univ. of Colo., Boulder). Phys. Fluids, 10: 2073-8(Sept. 1967).

A possible definition of an H function which is appropriate to describe weak turbulence in plasmas is introduced in terms of a probability introduced in the functional space spanned by instantaneous solutions of the Vlasov equation. The main point in an introduction of this function is to use an approximate probability. The nature of the H function thus defined is similar to that introduced by Boltzmann in kinetic theory. The time rate of change of the H function is computed and it is shown that the rate of change is negative for a weakly turbulent plasma and is zero for a stable plasma. (auth)

42063 VELOCITY OF MOVING STRIATIONS. Garscadden, A.; Lee, D. A. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). Phys. Fluids, 10: 2093-5(Sept. 1967).

The phase velocity of moving striations is calculated from the theory of Pekarek. It is shown that in the ambipolar diffusion regime this gives satisfactory agreement with recent measurements on the variation of striation velocity as the gas pressure is changed. (auth)

42064 METHOD OF ANALYSIS OF ION SWARM EXPERIMENTS. Barnes, William S. (Univ. of California, Livermore). Phys. Fluids, 10: 1941-52(Sept. 1967).

Means are presented for analyzing the data and estimating the values of parameters of interest in certain kinds of ion swarm experiments by use of maximum likelihood estimators. Means are also presented for estimating the fluctuations in the estimates of the parameters and several other statistics which are produced by the statistical fluctuations of the ion populations themselves. Methods are discussed for using these estimates to judge the appropriateness of the model hypothesized for both the ion transport process and the functioning of the experimental equipment. The use of the maximum likelihood methods in connection with several different initial ion distributions and several possible experimental geometries, is explored. The application of these methods to data from actual experiments involving the ions N^+ and N_2^+ in nitrogen is discussed. (auth)

42065 KINETIC THEORY OF TWO-TEMPERATURE PLASMA. Kruger, C. H.; Mitchner, M. (Stanford Univ., Calif.). Phys. Fluids, 10: 1953-61(Sept. 1967).

A closed formulation is presented for the electron energy equation together with the associated electron transport properties, applicable to a two-temperature partially ionized gas at intermediate and high degrees of ionization. Complete and simplified formulas to arbitrary levels of approximation in the Chapman–Enskog sense are given for the calculation of the electron thermal and electrical conductivities and thermal diffusion coefficients in the presence of a magnetic field. The effects of nonelastic collisions on electron transport property calculations are discussed and a criterion is presented for assessing when such collisions may be neglected. (auth)

42066 MOTION OF IONS IN GASES UNDER THE INFLUENCE OF NONHOMOGENEOUS FIELDS. Wieczorek, L. W. (Physikalisch-Technische Institut, Berlin). Beitr. Plasmaphys., 7: 23–41(1967). (In German).

A numerical method for the calculation of a solution of the rigidly linearized Boltzmann collision equation was given for the case when the ions are moved under the effect of a random electric field and under the effect of uncharged collisions. In an example, energy distribution functions for H^+ and H_2^+ ions and the corresponding neutral particles were given when the ions were moved in a linearly decreasing field in hydrogen. In an additional example, this result was applied to the ratios which occur in a normal glow discharge in hydrogen. (tr-auth)

42067 THE MECHANISM OF THE POSITIVE LOW PRESSURE COLUMN IN THE LIMITING CASE OF SMALL ELECTRON DENSITIES. I. GENERAL REVIEW. Rutscher, Alfred (Ernst-Moritz-Arndt-Univ., Greifswald, Ger.). Beitr. Plasmaphys., 7: 43-56(1967). (In German).

The positive low-pressure column was investigated under diffusion conditions for the case that the effect of the Coulomb interaction on the energy distribution function of the electron can be neglected. Ratios are illustrated in stationary, unlayered rare gas discharges by means of a simple model example. (tr-auth)

42068 THE MECHANISM OF THE POSITIVE LOW PRESSURE COLUMN IN THE LIMITING CASE OF SMALL ELECTRON DENSITIES. II. THE ENERGY DISTRIBUTION OF ELECTRONS. Pfau, S. (Ernst-Moritz-Arndt-Univ., Greifswald, Ger.). Beitr. Plasmaphys., 7: 57-66(1967). (In German).

In the homogeneous positive column of low-current rare gas discharges, the energy distribution of the electrons was measured and compared with the distribution functions calculated from the Boltzmann equations with consideration of the elastic and inelastic collision loss and with neglect of the electron interactions. For electron densities smaller than 10^{10} cm^{-3} a good agreement between experimental and theoretical values was found. In the parameter region of reduced gradients E/p_0 characteristic for the low-pressure discharge, the distribution functions in helium can be approximated, below the first excitation energy, by a Maxwell distribution, whereas for neon the Druyvesteyn distribution yields a good approximation. Over the excitation energy the curves deviate from a continuous Maxwell or Druyvesteyn distribution. The deviations are expressed in a sharp deficit in fast electrons. The single and double probe measurements carried out show that only with consideration of the respective form of the distribution can usable results be obtained. (tr-auth)

42069 SOLUTION OF THE LINEARIZED VLASOV EQUATION FOR AN ANISOTROPIC ELECTRON PLASMA. Bachmann, P. (Heinrich-Hertz-Institut, Berlin). Beitr. Plasmaphys., 7: 67-81(1967). (In German).

The initial value problem for the nonrelativistic linearized Vlasov equation for an electron plasma in a constant external magnetic field was investigated. A Volterra integral equation of the folding type for the Fourier transform of the density perturbation is equivalent to this initial value problem. By means of Laplace transformation this was solved. The solution, which is not specialized for given distribution functions, consists, as for the magnetic-field-free plasma, of three parts: the first depends only on the initial perturbation; the second is auxiliary to the equilibrium distribution; both show in general no time-harmonic behavior. The third part depends exponentially on

the time, and for it a dispersion equation (Landau solution) is valid. For the following initial perturbation: $f_1(x,v,t=0) = g(v_\perp, v_\parallel)\exp(ik^1 \cdot x)$ the density perturbation was investigated more accurately, in which for $g(v_\perp, v_\parallel)$ a bi-Maxwell distribution is assumed. Both the two first parts, which were developed by partial oscillations with the frequencies $n\omega_c$, show in general a transient behavior. For the case of the perpendicular broadening to the magnetic field, it was shown that all solution parts show the same time behavior; especially for the Landau solution no dispersion equation exists. With the help of the formalisms derived a simple initial value problem for cold plasma was calculated. (tr-auth)

42070 OBSERVATION OF PLASMA RESONANCES WITH THE HELP OF MICROWAVE EMISSION. Kliefoth, K.; Prinzler, H. (Heinrich-Hertz-Institut, Berlin). Beitr. Plasmaphys., 7: 83-95(1967). (In German).

The complex plasma admittance and the microwave emission has been observed in the range of plasma resonances at 1500 MHz (dipolar mode). The Tonks–Dattner modes due to standing electron waves are included in the observations. Relations are derived between the coefficients for transmission, reflection and emission using network calculations connected with the Nyquist formula. The noise temperature derived in this manner is only half the value of the electron temperature deduced from Langmuir probe measurements. This fact is confirmed by cavity measurements using the axial symmetric plasma mode. For the collision-free discharge an explanation is proposed assuming a "semithermionic" emitting zone near the wall, the interaction with an external electromagnetic field mainly takes place in this thick region. According to the well known theory of Parker, Nickel and Gould a steeply decreasing electron profile near the wall also enforces a limitation of the longitudinal waves to such a wall near region. (auth)

42071 THEORY OF THE SUBNORMAL COLUMN OF A LOW-PRESSURE GLOW DISCHARGE. Wilhelm, J.; Winkler, R. (Institut fuer Gasentladungsphysik, Greifswald, Ger.). Beitr. Plasmaphys., 7: 97-109(1967). (In German).

For the subnormal discharge in the area of low current density, which is characterized by the growth of the longitudinal field with decreasing discharge current, the space charge development in its current dependency results. General viewpoints for the representation of the problem and methods of solution are developed. In the case of a neglect of the effect arising from the interaction of excited atoms and molecules, a complicated coupled system of partial differential equations was obtained. The equation system contains the isotropic fraction of the distribution function of the electrons and the characteristic plasma parameter in their radial dependence. A power series solution for the simplified case that the isotropic fraction can be considered as position-independent was discussed. The approximation character of such a solution was investigated. The generalized expressions will be applied later to the case of the neon column in order to calculate the radial pattern of the characteristic magnitudes of the column plasma as a function of the discharge current. (tr-auth)

42072 RADIAL DISTRIBUTION OF THE CHARACTERISTIC QUANTITY OF A NEON COLUMN PLASMA IN THE SUBNORMAL DISCHARGE RANGE. Wilhelm, J.; Winkler, R. (Institut fuer Gasentladungsphysik, Greifswald, Ger.). Beitr. Plasmaphys., 7: 111-28(1967). (In German).

Starting the previously developed representations on the determination of the radial pattern of characteristic magnitudes of the subnormal column plasma, such a calculation was carried out for a model of the neon column. For this, the application of a Druyvesteyn distribution for the electrons in the first approximation was justified on the basis of other studies. The crystallization of the parameter characterizing the distribution follows over the energy balance of the electrons in the discharge current intensity. With the help of the developed calculation method, the radial pattern of the carrier concentrations, field strengths, and current densities were determined for a series of selected values of the discharge characteristic at $\underline{n}_g = 6.44 \times 10^{16}$ cm^{-3} and R = 2 cm. An extensive discussion of this magnitude was then made and simultaneously a comparison was carried out with the approximation solution of proportional concentration distribution. (tr-auth)

42073 KINETIC THEORY OF PLASMA OSCILLATIONS IN THE PLASMA CONDENSER. Wolschke, S. (Heinrich-Hertz-Institut, Berlin). Beitr. Plasmaphys., 7: 129-47(1967). (In German).

Stationary excitation of plasma oscillations by an external alternating electric field in a collisionless one-dimensional plasma layer (plasma condenser) is examined. For this linearized one-dimensional Vlasov equation is integrated along the one-electron characteristics, assuming the electrons are reflected specularly at the boundaries. In the case of a homogeneous plasma the resulting Fredholm integral equation for the electric field is solved exactly. The results agree with Shure's, received on the basis of distributional analysis à la Van Kampen and Case. In view of Tonks–Dattner resonances the resonance properties of the homogeneous plasma condenser are discussed. Contrary to the hydrodynamical theory only a finite number of resonances, increasing with the ratio r of layer diameter to Debye length is found. The ratio of series limit to main resonance position is nearly constant for r not too small. This agrees with Dattner's qualitative statements about Tonks–Dattner resonances found experimentally. However, the kinetical effect of series limit and another one of a second series of resonances at lower frequencies are masked by strong Landau damping in this region of dispersion. The method of characteristics used here has the advantage of easily being generalized for the case of an inhomogeneous plasma condenser. For this case an integral equation for the electric field is derived in full analogy to the procedure employed for the homogeneous plasma. Finally the kernel of this equation is specialized for a parabolic static potential. (auth)

42074 ON THE CONCEPT OF EFFECTIVE DENSITY AND EXPERIMENTAL TESTS OF PLASMA-WAVE THEORY. Lee, Kai-fong (Univ. of California, San Diego, La Jolla). J. Appl. Phys., 38: 3787-90(Aug. 1967).

It is shown that when a formulation previously made is applied to the configuration of Malmberg and Wharton, it accurately predicts the observed dispersion and damping of electron plasma waves, provided that the effects of both density variation and conducting boundary are taken into consideration. Following this favorable comparison with experiment, some explicit results of the two-stream instability ladder are presented. (M.H.R.)

42075 INFLUENCE ON PLASMA OF EXTREMELY LOW FREQUENCE ELECTROMAGNETIC WAVES. Schumann, W. O. (Technische Hochschule, Munich). Z. Angew. Phys., 23: 261-3(1967). (In German).

The influence of electromagnetic waves on small charged particles is discussed, if the magnetic field of the wave also is cooperating. This occurs especially with waves of extremely low frequencies. (auth)

42076 EXPERIMENTS WITH SYNCHROTRON RADIATION. Haensel, Ruprecht; Kunz, Christof (Univ., Hamburg. Deutsches Elektronen-Synchrotron, Hamburg). Z. Angew. Phys., 23: 276-95(1967). (In German).

A brief historical introduction is followed by an outline of the basics of synchrotron radiation theory; analytic formulas for the power distribution are given. A comparison is drawn between synchrotron radiation and radiations from other sources. The experimental tests of the theory are summarized. Several instrumental problems are outlined which are peculiar to experimenting with synchrotron radiation in the far ultraviolet. Special attention is paid to solid-state problems in a summary of those experiments in which the synchrotron is employed as a radiation source. (auth)

42077 INFLUENCE OF MOVING STRIATION ON MICROWAVE REFLECTION OF PLASMA. Terayama, Kikuo; Takamoto, Teruo (Kansai Univ., Japan). Denki Gakkai Zasshi, 86: 281-8(Feb. 1966). (In Japanese).

When the microwave reflection action of plasma in the discharge tube is observed, small oscillations in the plasma are observed to effect the microwaves. In the first experiments reported, the cause of these oscillations was studied in the absence of an external magnetic field. For this purpose, the moving striation was observed by a photo-transistor and double probe, and the results were compared with the oscillation in microwave reflection power. It is known that the moving striation is an electron density wave which propagates from anode to cathode, while according to the results of measurements by the double probe method, it was seen that the moving striation was accompanied by electron temperature wave. Therefore, the results indicated that oscillations of electron density and collision frequency occur in the moving striation, and these oscillations cause the oscillations in microwave reflection power. Then, an external magnetic field was added to the plasma and its intensity was varied. In this instance, the amplitude of microwave oscillation varied with the magnetic field even in the range where the moving striation did not vary. When the dc and oscillation parts of the microwave reflection power were measured with the magnetic field, it was found that the amplitude of oscillation part had a minimum in the range of the magnetic field in which the dc component was maximal on both sides of maximum dc. In the range of minimum oscillation (maximum dc), the wave form of the oscillation varied from the standard mode which had the same frequency as the moving striation to the

half-wave rectifying mode, M-type mode, and multiple oscillation mode with increasing magnetic field. An attempt to explain these results was made qualitatively by analyzing the reflection mechanism on the basis of the fact that both electron density and collision frequency varied due to the moving striation. (BBB)

42078 QUASI-UNIDIMENSIONAL FLOW IN A PROGRESSIVE WAVE PLASMA ACCELERATOR. Peyret, Roger (Univ., Paris). J. Mecan., 5: 471-515(Dec. 1966). (In French).

The flow of a perfect compressible conducting fluid in a progressive wave accelerator is studied. The general two-dimensional equations governing this sort of flow are developed. The equations for the unidimensional approximation are solved by the classical method of small perturbations. The solution obtained by this method does not represent the flow at large distances from the entry of the accelerator. Another method, the "method of multiple coordinates," is then employed. As an example of terminal effects, flow resulting from the field created by a ring of current is calculated. Flow accelerated by the progressive field is shown to decelerate in the region of the exit from the canal. (BBB)

42079 ELECTROSTATIC RELAXATION WAVE IN AN ISOTROPIC LORENTZ GAS. Derfler, Heinrich (Stanford Univ., Calif.). Phys. Fluids, 10: 1636-46(Aug. 1967).

A calculation of the dispersion of electrostatic waves in a Lorentzian electron gas takes Landau damping and the detailed balancing of elastic electron–atom collisions rigorously into account. As a special case, the further analysis is restricted to rigid elastic spherical molecules and a monoenergetic distribution of electron velocities. This eliminates Landau damping and Van Kampen modes in favor of new effects associated with the collision process. One thus exposes a discrete spectrum of pseudosound waves and a continuous spectrum of relaxation waves both due to the infinitely many harmonic patterns into which electrons can be scattered by elastic spheres. (auth)

42080 NONLINEAR LANDAU DAMPING IN THE RANDOM PHASE APPROXIMATION. Rand, S. (Univ. of California, San Diego, La Jolla). Phys. Fluids, 10: 1629-35(Aug. 1967).

Expressions are obtained for Landau damping of electron plasma waves, in the steady state, by balancing nonlinear effects and collision effects. The random phase approximation is used. In this context, a quantum effect, which may be important at typical laboratory plasma densities, is discussed. It is pointed out that the absorption of energy from the wave, in discrete quantum jumps, is far more significant with relation to resonance effects than is the case when a nonresonant situation is being studied. The classical and quantum-limiting results are compared. It is found that although in both cases the steady-state Landau damping is proportional to the inverse square of the wave field strength in the limit of strong fields, the expansion parameters differ in the classical and quantum limits. (auth)

42081 KINETIC EQUATION FOR A WEAKLY UNSTABLE PLASMA. Price, John C. (Univ. of California, Berkeley). Phys. Fluids, 10: 1623-8(Aug. 1967).

A kinetic equation is derived for a spatially uniform unstable plasma. The collision term contains the effects of waves (plasmons) in the system as well as the terms of the Lenard–Balescu equation. The wave effects arise from initial fluctuations in the system and from waves emitted by particles; the latter are represented by a time integral over earlier times. The limitation of the work is the neglect of three particle effects (mode coupling). (auth)

42082 TWO-PARTICLE CORRELATION IN A STATIC PLASMA. Pinney, Edmund (Univ. of California, Berkeley). Phys. Fluids, 10: 1619-22(Aug. 1967).

The two-particle correlation theory for a static plasma is developed by an inverse application of Poisson equation theory, a less cumbersome and restrictive method than the usual Fourier theory. The theory is developed in computable form for nonfrigid two-component plasmas, and completely for warm plasmas. In the latter case it is found that the two-particle correlation function has only a small effect, and that only in the sheath. (auth)

42083 ENERGY LOSS FROM A THETA PINCH. Green, T. S.; Fisher, D. L.; Gabriel, A. H.; Morgan, F. J.; Newton, A. A. (United Kingdom Atomic Energy Aughority, Abingdon, Berkshire, Eng.). Phys. Fluids, 10: 1663-75(Aug. 1967).

Electron temperatures measured in a megajoule theta pinch are found to be limited to ~300 eV over the pressure range 10 to 50 mtorr and to vary during the discharge time in a nonadiabatic manner. The plasma diamagnetism shows a rapid decay at the time of maximum Poynting flux and since there is no particle loss at this time there must be an energy loss of the order of the energy input rate. Variation of the concentration of oxygen, which is the major impurity, by addition of known amounts or by reduction of the intrinsic 1.5% an order of magnitude with a new pre-ionization technique, indicates an energy loss rate of 2×10^{13} erg cm^{-3} sec^{-1} at zero oxygen concentration. It is not possible to account for this loss by radiation in the continuum spectrum. A simple model of axial thermal conduction is developed in which the energy is transported to cold regions beyond the ends of the theta-pinch coil. The model predicts a limiting temperature due to the steep temperature dependence of the conductivity coefficient $K = \alpha T^{\frac{5}{2}}$. Other predictions of the model concerning the variation of diamagnetism are found to be valid. Finally the results of other theta-pinch experiments are examined and some are found to fit the model. (auth)

42084 ELECTROMAGNETIC WAVE SCATTERING FROM A HIGH-TEMPERATURE PLASMA. Pechacek, R. E.; Trivelpiece, A. W. (Univ. of Maryland, College Park). Phys. Fluids, 10: 1688-96(Aug. 1967).

Electromagnetic wave scattering from a tenuous high-temperature plasma is studied for cases where relativistic corrections must be included in the analysis to obtain a valid description for the spatial and spectral distribution of the scattered radiation. The peak of the spectrum of scattered radiation is shifted toward a shorter wavelength, e.g., the peak of the backscattered radiation from a 50-keV plasma is at 4000 Å for 6943-Å incident radiation. The spectrum is no longer symmetrical about the scattering peak. It is also shown that the correct spectrum of scattering for a confined high-temperature plasma is not the same as the spectrum obtained using the model infinite plasma irradiated by a homogeneous plane wave. The difference in these two situations is a term of order v/c which is negligible only for the zero-order case (i.e., $v/c \ll 1$). Thus, experiments to study the scattering of laser beams from high-temperature plasma should take account of these effects. (auth)

42085 ANOMALOUS DIFFUSION IN A WEAKLY TURBULENT PLASMA. Macmahon, Alan B.; Drummond, William E. (Univ. of Texas, Austin). Phys. Fluids, 10: 1714-19(Aug. 1967).

A given spectrum of plasma oscillations, representing a state of weak turbulence, is considered in a uniform Vlasov plasma in a strong magnetic field. The parallel velocity and transverse spatial diffusion coefficients for thermal particles are found by studying the motion of a test particle. Diffusion results from the zero-frequency component of the electric field seen by the test particle. Two nonlinear processes contribute to this component: modification of the field seen by the test particle by high-frequency modulation of its velocity, and excitation of low-frequency "virtual waves" by nonresonant mode coupling. The latter effect dominates ion diffusion, increasing it by the factor $(m_i/m_e)^2$; for electrons, the two effects almost cancel, decreasing the diffusion by the factor $(k\lambda_D)^4$. Thus the low-frequency virtual waves must not be neglected in estimating anomalous diffusion or heating associated with a given high-frequency spectrum. (auth)

42086 TRANSPORT COEFFICIENTS OF IONIZED GASES. Mason, E. A. (Univ. of Maryland, College Park); Munn, R. J.; Smith, Francis J. Phys. Fluids, 10: 1827-32(Aug. 1967).

The repulsive and attractive screened Coulomb potentials may be used to represent interactions among charged particles in a gas. The classical Chapman–Enskog collision integrals are calculated for these potentials over a wide range of reduced temperatures, equivalent to a wide range of electron densities and temperatures. At high temperatures the repulsive and attractive collision integrals are equal and agree with the earlier calculations of Kihara and Liboff. At lower temperatures the attractive collision integrals grow larger than the repulsive collision integrals as the temperature falls, and both grow apart from the previous results. It is shown that quantum effects are large in high-density plasmas at all temperatures and in low-density plasmas at very high temperatures. (auth)

42087 MEASUREMENT OF SHOCK-WAVE STRUCTURE IN HELIUM–ARGON MIXTURES. Center, R. E. (California Inst. of Technology, Pasadena). Phys. Fluids, 10: 1777-84(Aug. 1967).

Shock-wave density profiles have been measured for each component in helium–argon mixtures over the argon mole fraction range from 0.011 to 0.87. The shock waves were produced by a shock holder in the flow field near the exit of a Mach 2 nozzle. The species densities were derived from spectrally resolved measurements of the radiation from gas atoms excited by an electron beam. The measured species density ratios across the shock waves agreed within 7% with each other and with theory. Diffusive separation of the mixture was observed within the shock wave and the helium was compressed upstream of the argon in all cases. No initial acceleration of the argon was observed for small argon mole fractions contrary to the continuum calculations of Sherman. Diffusion effects resulted in considerable broadening of the shock wave, and for argon mole fractions of 0.1 to 0.2 the maximum-slope thickness of the mixture was almost three times the corresponding value for a pure gas. (auth)

42088 QUASI-ONE-DIMENSIONAL, NONEQUILIBRIUM GAS DYNAMICS OF PARTIALLY IONIZED TWO-TEMPERATURE ARGON. Hoffert, Martin I.; Lien, Hwachii (General Applied Science Labs., Westbury, N. Y.). Phys. Fluids, 10: 1769-77 (Aug. 1967).

A set of equations governing the quasi-one-dimensional flow of a nonequilibrium argon plasma is formulated. The kinetic model includes ionization by atom–atom and electron–atom impacts, together with the three-body recombination counterparts of these processes. The electron gas temperature—a key variable in controlling ionization reaction rates in a noble gas—is not necessarily equal to that of the heavy particles and must in general be found by simultaneous solution of a differential electron energy equation together with the usual conservation equations. Numerical solutions are obtained for the special case of the relaxation zone behind strong normal shocks which give good agreement with shock tube measured ionization times. For these normal-shock calculations, a local steady-state approximation to the electron energy equation is found to be useful in view of an insensitivity, demonstrated by the numerical results, to arbitrarily selected initial values of post-transiational shock electron temperature. (auth)

42089 CYCLOTRON HARMONIC RESONANCES IN THE FREQUENCY CONVERSION OUTPUT POWER OF A PLASMA. Tetenbaum, S. J. (Lockheed Palo Alto Research Lab., Calif.). Phys. Fluids, 10: 1855-7(Aug. 1967).

Electron cyclotron harmonic resonances have been found in the second harmonic and sum frequency powers emerging from an electrodeless helium discharge. The resonances are due to cyclotron harmonic interactions with the incident waves followed by frequency conversion. (auth)

42090 THICKNESS OF A SHOCK WAVE IN HYDROGEN. Gross, Robert A. (Columbia Univ., New York). Phys. Fluids, 10: 1853-5(Aug. 1967).

Thickness of a shock wave in hydrogen is estimated over a wide range of shock velocity. Different speed regimes have their own characteristic shock thickness. Very strong shock thickness is proportional to the Coulomb mean free path in the post shock plasma. (auth)

42091 LIMITS OF VALIDITY OF BORN APPROXIMATION IN MICROWAVE SCATTERING FROM TURBULENT PLASMA. Granatstein, V. L. (Bell Telephone Labs., Whippany, N. J.); Buchsbaum, S. J. Phys. Fluids, 10: 1851-3(Aug. 1967).

Microwave scattering from a turbulent weakly ionized plasma column is studied. The scattering cross section is proportional to the mean-square plasma density fluctuation, $\langle \tilde{n}^2 \rangle$, as predicted in the Born approximation for $\langle \tilde{n}^2 \rangle^{\frac{1}{2}}$, up to 5% of the critical density. (auth)

42092 A UNIFIED TREATMENT OF THE RELAXATION PHENOMENON IN RADIATING ARGON PLASMA FLOWS. Oettinger, Peter E.; Bershader, Daniel (Stanford Univ., Calif.). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 5: 1625-32(Sept. 1967).

The electronic relaxation of a shock heated, nonequilibrium argon plasma flow is treated by means of a combined theoretical and experimental investigation. A physical model of the flow is postulated which includes the microscopic collisional and radiative processes. When coupled with the macroscopic conservation laws, this leads to a rigorous formulation of the equations governing the relaxing flow. A resultant numerical solution is compared to time-resolved interferograms of the flow behind a strong incident shock front propagating into argon gas. Good agreement is obtained between theory and experiment for incident shock Mach numbers of 11 to 18 propagating into argon at pressures of 3 to 5 mm Hg. (auth)

42093 EXCITATION AND DETECTION OF MAGNETOACOUSTIC WAVES IN A ROTATING PLASMA ACCELERATOR. Wilson, G. L.; Woodson, H. H. (Massachusetts Inst. of Tech., Cambridge). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 5: 1633-41(Sept. 1967).

A pulsed experiment is described in which a helium plasma is heated electrically to a velocity of 20,000 m/sec in a toroidal enclosure. Measurements of input current, average gas velocity, and electrical conductivity vs input power are described and compared with the results of a two-dimensional Hartmann flow theory in which the effects of gas property variations with temperature are included. A pulsed electromagnetic system is used to produce longitudinal standing waves in the moving gas. Measurements of the resulting natural frequencies are made and compared with the predictions of a one-dimensional theory. The waves are observed in the transition region between the acoustic and magnetoacoustic modes, with electrical conductivity as the controlling parameter. A fast-wave instability is predicted and observed. (auth)

42094 BLOWING OF CURRENT PATTERNS IN NONEQUILIBRIUM PLASMAS. Sherman, Arthur (General Electric Space Sciences Lab., King of Prussia, Pa.); Yeh, Hsuan. AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 5: 1689-90(Sept. 1967).

A description is given of how blowing occurs in a plasma whose conductivity is nonuniform (for instance due to nonequilibrium ionization) and it is also shown how such effects can be included in MHD flow analysis. (M.O.W.)

42095 ELECTRODE FEED SYSTEM FOR SEGMENTED ELECTRODE MHD ACCELERATOR. Durran, D. A.; Grabowsky, W. R. (Aerospace Corp., El Segundo, Calif.). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 5: 1714-5(Sept. 1967).

An electrode feed system for parallel electrode groups is described. This system is particularly applicable to pulsed systems. Experimental results obtained with this electrode system are presented. (M.O.W.)

42096 PULSATION OF A ROTATING PLASMA CYLINDER AT ZERO TEMPERATURE GRADIENT. Ryazanov, E. V. Dokl. Akad. Nauk SSSR, 175: 542-4(July 21, 1967). (In Russian).

Solutions for plasma cylinder pulsations are derived, assuming that the radial rate v_r of the particle is a linear function of its distance r from the symmetry axis ($v_r = r/\mu(t)dt$) where the $\mu(t)$ is an arbitrary time function. An attempt is made at resolving the problem of one-dimensional axially symmetric unsteady flow of a nonviscous perfectly conducting ideal gas under Newtonian gravitational forces assuming that the temperature depends only on the time and transversal rate component $v_\varphi \neq 0$. (R.V.J.)

42097 THEORETICAL STUDY OF A CESIUM PLASMA IN EQUILIBRIUM. Cheret, Michel; Sayer, Bernard; Berlande, Jacques; Manus, Claude (CEN, Saclay, Gif-sur-Yvette, France). Compt. Rend., Ser. A and B, 264: 1340-2(May 8, 1967). (In French).

By use of a formalism close to that proposed by Bates for the study of the recombination of the H^+ ion, an attempt was made to determine the characteristics of a cesium plasma in stationary regime in the presence of a continuous electric field. The case of a homogeneous plasma, constituted by cesium atoms in different states of excitation, Cs^+ in the ground state, and free electrons with a Maxwell velocity distribution was considered. Equations were derived with which it is possible, with a given temperature and electron density, to calculate the population of the excited levels, the electric field, and the current density in stationary regime. (J.S.R.)

42098 EXPERIMENTAL INVESTIGATION OF A GLOW DISCHARGE IN A TOROIDAL TUBE. Shohoud, W.; Kocian, P. (Czech Technical Univ., Prague). Czech. J. Phys., 17: 773-9 (1967).

A glow discharge in a toroidal tube with axial discharge current is investigated. The investigation was carried out for a discharge as a whole, not for electrodal zones and the positive column separately. The volt–ampere characteristics for different pressures and Paschen's curves for different gases were measured. The curves obtained are compared with analogous ones for a cylindrical tube. The conditions for the existence of a glow discharge in a toroidal tube and the processes passing there are discussed on the basis of the measured curves. The experiments were carried out in air, helium, argon and neon. (auth)

42099 KINETICS OF THE POST LUMINESCENCE OF He–Ne PLASMAS. Lisitsyn, V. N.; Chebotaev, V. P. Zh. Prikl. Spektrosk., Akad. Nauk BSSR, 6: 594-7(May 1967). (In Russian).

The mechanism of generation in the post luminescence of high-current pulse discharge in He–Ne mixtures was investigated. The role of the 2^3S atoms of He in the excitation of the 2s level of Ne was shown by the optical pumping method with He tube light. Investigation of the spontaneous emission with the 2s and 2p levels of Ne indicated the different structures of population of these levels in the post-luminescent discharge. The effect of admixtures on the generation in the post-luminescent period was studied. The obtaining of generation in lines of nitrogen and molecular hydrogen in the post-luminescent discharge appeared as secondary results of this study. (tr-auth)

42100 POSITIVE COLUMN OF A LOW-PRESSURE DISCHARGE IN A TOROIDAL TUBE. Kocian, P. (Czech Technical Univ., Prague). Czech. J. Phys., 17: 546-9(1967).

The positive column of a low-pressure glow discharge in a toroid is investigated. The radial distribution of charged particles, the distribution of the electric field and the course of

the equipotentials are derived from theory. Assuming the curvature of the walls in the direction of the toroid axis to be negligible one can solve the problem as that of a positive column between concentric circular cylinders. (auth)

42101 EXCITATION OF UHF PLASMA OSCILLATIONS IN THE ANODE REGION. Drost, H.; Behlke, H.; Schulz, G.; Pupke, H. Monatsber. Deut. Akad. Wiss. Berlin, 8: 402-5 (1966). (In German).

The possibility of oscillation excitation in plasma occurring without the introduction of a supplementary beam of fast primary electrons was investigated. The results show that, without the input of electrons, uhf oscillations can be detected at no place either within or without the discharge, however, the discharge parameters were varied in a wide interval. (J.S.R.)

42102 RADIATION ECHO. Oraevskii, A. N. (Lebedev Inst. of Physics, Moscow). Usp. Fiz. Nauk, 91: 181-91(Feb. 1967). (In Russian).

Processes are described that occur in an ensemble of radiations that interact with each other via a magnetic field, and especially radiation and superradiant processes in spin systems, with due allowance for the relaxation processes occurring in them and the homogeneous and inhomogeneous line broadening due to these processes. Echo phenomena in a spin system situated in a magnetic field and their time evolution are described from the point of view of quantum theory, and the results are extended to include the general case of an ensemble of two-level systems. The analog of spin echo in a molecular beam is described. Various peculiarities of coherent radiation and photon echo in the optical band are discussed and laser experiments aimed at experimentally observing single and multiple echoes are described. (ATD)

42103 RADIAL AND AXIAL DEVELOPMENT OF THE LUMINESCENCE IN A SPARK CHANNEL INVESTIGATED WITH A WISCH CAMERA. Koppitz, Joern (Univ., Hamburg). Z. Naturforsch., 22a: 1089-97(July 1967). (In German).

The radial and axial development of the hot plasma spark channel is treated. The measured radial expansion is in good agreement with the theory of Braginskii, but not with that of Drabkina. A formula for the dependence of the channel radius on external parameters is derived. Axial inhomogeneities were found to be the consequence of an inhomogeneous development in the predischarge channel during the streamer stage. (auth)

42104 QUANTUM STATISTICS OF HIGH-TEMPERATURE PLASMAS IN THERMODYNAMIC EQUILIBRIUM. Ebeling, W.; Hoffmann, H. J.; Kelbg, G. (Univ., Rostock, Ger.). Beitr. Plasmaphys., 7: 233-48(1967). (In German).

High temperature plasmas are investigated on the basis of quantum theory. A new method for the calculation of the thermodynamic properties is developed. According to the method of Morita effective potentials are introduced. They permit the evaluation of the partition function with the well-known formalism of classical statistical mechanics. The first corrections added to Debye's limiting law of the free energy are expressed by the two particle Slater sum $S_2(r)$. A Bloch equation for $S_2(r)$ is derived and is solved in the Fourier representation by a development according to the interaction parameter $\xi = e^2/kT\lambda$, λ being the thermal wavelength. The effects of symmetry are taken into account. The free energy is calculated explicitly up to the order of ξ^2. In the case of small concentrations the results agree with that derived by Trubnikow and Elesin. Effects of symmetry neglected, up to the order of ξ^2 the formula of DeWitt is obtained. (auth)

42105 INTERPRETATION OF COLLECTIVE PLASMA WAVE DAMPING IN A COLLISION FREE PLASMA. Buenemann, D. (Univ., Kiel). Atomkernenergie, 12: 225-32(1967). (In German).

A plasma is considered to be collision free if only collective forces are acting on the particles. It is shown that damping of collision free plasma waves can be interpreted as a simple energy exchange phenomenon between polarization clouds and electromagnetic fields. The so-called Landau damping of linearized plasma waves corresponds to the following phenomenon: polarization cloud particles travel with constant speed into the space—at each moment generating new polarization clouds by their electromagnetic fields the particles of which react in the same way. Finally an interpretation of the eigenfunction development of van Kampen is found by considering the equivalent two-sided Laplace transformation. (auth)

42106 SOME RESULTS OF EXPERIMENTS ON DISCHARGES IN SHOCK TUBES WITH PARALLEL CONDUCTORS. Kravarik, J. (Czech Technical Univ., Podebrady). Czech. J. Phys., 17: 521-6 (1967).

Measurements on shock tubes with electrodes in the form of parallel conductors are presented. The shape of plasma moving in the said tube, the dependence of the plasma velocity on the pressure of air and helium and hydrogen filling the tube are discussed. Measurements are given of the dependence of the plasma velocity on the distance from the discharge origin and on the voltage across the condenser battery. (auth)

42107 KINETIC MODEL OF TONKS-DATTNER RESONANCES IN A POSITIVE COLUMN. Baldwin, D. E.; Hirshfield, J. L. (Yale Univ., New Haven). Appl. Phys. Lett., 11: 175-7(Sept. 15, 1967).

Widely reported resonances in positive columns are described by a kinetic model in which electrons reflected at the sheath provide a plasma wave reflection mechanism which has been lacking in earlier fluid theories. Application of a weak magnetic field is shown experimentally to destroy the resonances when the gyro-radius falls below the dimension of the reflection zone. (auth)

42108 MULTIPLE SCATTERING OF SHORT WAVES BY A SYSTEM OF INTERACTING PARTICLES. I. Borovoi, A. G. (Inst. of Physics and Technology, Novosibirsk, USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 4, 97-101(1967). (In Russian).

A plane wave multiply scattered by a nonideal gas was studied in order to determine the influence of particle interactions on multiple scattering of radiation. The magnitude of a mean field for an assigned wave length and interaction potential was obtained with precision, considering particle pair collisions. (R.V.J.)

42109 CHARACTERISTICS OF A HIGH-POWER NITROGEN PLASMA JET. Nomura, Shigeaki (National Aerospace Lab., Japan); Komura, Hirotsugu. Mitsubishi Denki Lab. Rep., 41: 494-502(Mar. 1967). (In Japanese).

Characteristics are described of a high-power nitrogen plasma jet developed as a heat source for a hypersonic wind tunnel. The measurement of the thermal loss has revealed that the high-temperature gas with a temperature of 1.1×10^{4}°K and an enthalpy of 1.4×10^{4} cal/g can be obtained at the maximum power input of 60 kW. The spectroscopical measurement was made to have directly the absolute values of electron density and temperature as well as their radial distributions. It has been clarified, as a result, that the mean gas temperature measured spectroscopically agrees well with the mean temperature calculated from the energy balance between the thermal input and the thermal loss, that the temperature distribution is fairly uniform throughout the sectional area of the nozzle except the extreme vicinity of the wall, and that the electron density is in the order of $10^{16}/cm^3$. (NSA of Japan)

42110 WAVE PROPAGATION IN A STRATIFIED COMPRESSIBLE MAGNETOPLASMA WITH A STATIC PRESSURE GRADIENT. Burman, R. (Victoria Univ. of Wellington, N. Z.). Proc. IEEE (Inst. Elec. Electron. Eng.), 55: 1528-9(Aug. 1967).

Transverse propagation to the magnetostatic field of coupled electromagnetic and electroacoustic waves in a horizontally stratified, horizontally magnetized compressible electron plasma is described. Vertical electrostatic and gravitational fields are allowed for. Some first-order coupled-wave equations are derived and propagation constants of characteristic waves are obtained. (auth)

42111 SELF-CONTAINED DISCHARGE CURRENT IN A HIGH VACUUM IN CROSSED ELECTRICAL AND MAGNETIC FIELDS. Reikhrudel, E. M.; Sheretov, E. P. (Moscow State Univ.). Radiotekh. Elektron., 11: 532-5(Mar. 1966). (In Russian).

A self-contained discharge current in a high vacuum in crossed electric and magnetic fields was previously investigated, considering a uniform distribution of the negative space charge in the discharge interval. The current density obtained by theoretical calculations exceeded the experimental data several fold. An attempt was made of calculating a self-contained discharge in crossed electric and magnetic fields considering nonuniform distribution of the space charge due to the increase of electron cascades in the discharge interval. (tr-auth)

42112 INFLUENCE OF THE RADIAL ELECTRIC FIELD ON THE MAGNETOMECHANICAL EFFECT IN AN UNBALANCED PLASMA. Urazakov, E. I. Radiotekh. Elektron., 11: 550-3 (Mar. 1966). (In Russian).

The torque acting in a nonisothermic plasma column depends on the ratio of radial electron and ion currents. In an experimental verification, the above ratio was varied by superimposing a voltage between the plasma and an additional conducting wall mounted in a dielectric envelope containing the plasma. The conducting wall consisted of seven hollow metal cylinders. The torque acting upon a solid body suspended in the tube, in a region remote from the conducting wall, was measured. It is found that, as the plasma-wall

voltage increases, the torque decreases, passes zero, and changes its sign which corresponds to a reversing of the direction of plasma rotation in the same magnetic field. As the voltage increases further, the torque quickly reaches the value that corresponds to the ambipolar diffusion, and then increases slowly. Curves illustrating details of the magnetomechanical effect are supplied. (ATD)

42113 EXACT EQUATION OF STATE FOR A 2-DIMENSIONAL PLASMA. May, R. M. (California Inst. of Tech., Pasadena). Phys. Lett., 25A: 282(Aug. 14, 1967).

A fully exact expression for the equation of state for a classical system of N positive and N negative charges all interacting with each other through 2-dimensional Coulomb potentials is presented. (auth)

42114 DECAYS OF ION-SOUND OSCILLATIONS IN A WEAKLY IONIZED PLASMA. Khirseli, E. M.; Tsintsadze, N. L. (Inst. of Physics, Tbilissi, USSR). Phys. Lett., 25A: 279-80(Aug. 14, 1967).

The process of fusion of two ion-sound waves is considered. As a result of this fusion an acoustic wave is generated. The increment of the acoustic wave increase is calculated. (auth)

42115 PARAMETRIC RESONANCE IN MAGNETOSONIC WAVES IN PLASMA. Frank-Kamenetskii, D. A.; Smirnov, Yu. N. (Kurchatov Atomic Energy Inst., Moscow). Phys. Lett., 25A: 287-8(Aug. 14, 1967).

The analysis of perturbed trajectories of particles in a modulated magnetic field shows that change of phase relations of particle motion and electrical field of the wave can lead to the absorption of energy at the undertones of the cyclotron frequency. (auth)

42116 WAVES IN A PLASMA IN A MAGNETIC FIELD. Stainer, Howard Martin. College Park, Md., Univ. of Maryland, 1966. 87p.

Thesis.

Two examples of slightly nonlinear wave propagation in a collisionless plasma permeated by a uniform background magnetic field $\underline{B}_0$ are discussed. The first calculation considers externally generated electromagnetic waves propagating along $\underline{B}_0$ in a plasma described by the first three moment equations obtained from the Vlasov equation. The second calculation is motivated by the investigation of the line splitting observed in plasma radiation (type-II radio bursts) from the Sun. Here internally excited longitudinal electrostatic oscillations propagating at arbitrary angles with respect to $\underline{B}_0$ are considered. (Disser. Abstr.)

42117 THE KINETIC EQUATION FOR AN UNSTABLE PLASMA IN STRONG, PARALLEL, DC ELECTRIC AND MAGNETIC FIELDS AND PLASMA STREAMING INTO A TRANSVERSE MAGNETIC FIELD. Ossakow, Sidney Leonard. Los Angeles, Univ. of California, 1966. 120p.

Thesis.

The response of a homogeneous plasma, in a strong uniform magnetic field, $\underline{B}_0$, to the sudden application of a strong, uniform electric field is studied in a self-consistent formulation which treats the coupled equations for the one-particle and two-particle distribution functions resulting from neglect of three-particle correlations. As in earlier work on the case $\underline{B}_0 = 0$, the electric field is assumed to be large compared to that which produces a "runaway current," so that particle-wave interactions should dominate. In the limit of strong magnetic field, use of the Bernstein–Kulsrud expansion in $k_\perp r_{ic}$ (ratio of ion cyclotron radius to wavelength) makes the problem effectively one-dimensional, eliminating the need for factorization assumptions of the form $f(v) = f_{||}(v_{||}) f_\perp(v_\perp)$ (where $||$ and $\perp$ refer to the electric field direction) used in the $\underline{B}_0 = 0$ case. Only the dominant contributions to the diffusion in velocity space, arising from the fastest growing waves, are retained. Other simplifications result from the assumption of unequal electron and ion temperatures, but it proves necessary to specify the ratio T_e/T_i, rather than simply assuming it to be large. In sharp contrast to the case $\underline{B}_0 = 0$, it is found that the diffusion affects only those electrons which have, in the ion rest frame, velocities of order $(m/M)^{1/3}$ of the electron thermal speed. No appreciable "quasi-linear" effects, such as the current limitation found in the $\underline{B}_0 = 0$ case, are therefore to be expected; the results of numerical calculations confirming this are summarized. The simplest time-independent boundary value problem of a plasma streaming into a transverse magnetic field, in a quasi-linear fashion is solved, starting from first principles. In place of the semi-infinite configuration studied by Rosenbluth, in which there is two streaming in both the x and y directions with the magnetic field in the z direction, the first problem discussed here is that of a "cold" plasma "slab," of thickness $d \ll \sqrt{r_{ce} r_{ci}}$, the geometric mean of electron and ion cyclotron radii. (Disser. Abstr.)

42118 STATISTICAL MECHANICS OF A PARTIALLY IONIZED HYDROGEN PLASMA. Kepple, Paul Clarence Jr. University Park, N. Mex., New Mexico State Univ., 1966. 132p.

Thesis.

It is shown that it is possible to calculate the thermodynamic functions of a partially ionized hydrogen plasma without introducing a hard core or an arbitrary cutoff into the potential. The calculation of the partition function of the plasma is divided into four parts: (1) free particles, (2) bound states with discrete spectrum, (3) bound states with continuous spectrum and symmetric charge distributions, and (4) bound states with continuous spectrum and nonsymmetric charge distribution. (Disser. Abstr.)

42119 EXPERIMENTAL INVESTIGATION OF THE INTERACTION BETWEEN THE ELECTRON GAS AND THE EXCITED ATOMS IN A PLASMA BY MEANS OF A XENON LASER. Freiberg, Robert Jerry. Urbana, Ill., Univ. of Illinois, 1966. 135p.

Thesis.

The study of the interaction between the electron gas and the atoms in excited states has been undertaken for a gas discharge situated in a high gain optical cavity. Of particular interest is the effect of lasering upon this interaction. Spatially resolved electron density and electron temperature measurements are presented for a dc excited 3.51 μ ($5d_{33} \rightarrow 6p_{22}$) xenon laser operating in a capillary bore tube over a pressure range of 12.5 to 25.5 m torr. Anode directed gradients in the electron and neutral gas densities are observed and are attributed to electrophoretic effects present in the closed capillary discharge tube. As a result of these gradients, the local population inversion along the axis of the tube varies and, consequently, affects the output of the 3.51 μ laser. The influence of lasering upon these low-pressure capillary xenon discharges is investigated experimentally by periodically spoiling the Q of the laser cavity by means of a mechanical chopping wheel. It is observed that lasering noticeably alters both the state of the electron gas and the population of the excited xenon atoms. The current of the dc excited discharge is quenched up to 0.02% during lasering due to laser-induced variations of the electron density and mean energy. Spatially resolved microwave cavity measurements indicate that the electron number density may experience increases and decreases depending upon local discharge conditions. Microwave radiometric measurements reveal that the electron temperature is also affected by lasering. Variations in the microwave cavity Q and in the electron drift velocity due to lasering are in good qualitative agreement with the radiometric data. Confirming spectroscopic observations of laser-induced changes in the spontaneous radiation along the discharge tube are presented. It is demonstrated that excitation of the 6s metastables via electronic impact is instrumental in populating the lower laser level and contributes to a reduction in the local population inversion. Evidence for various radiative and collisional mechanisms responsible for the propagation of the laser-induced perturbation from the $5d_{33}$ and $6p_{22}$ levels to other excited levels is also presented. It is suggested that laser media in general can be analyzed and improved upon by studying the laser-induced changes in the excitation and relaxation processes. (Disser. Abstr.)

42120 SCATTERING OF TEST PARTICLES BY WAVES IN PLASMAS CONTAINING SUPRATHERMAL PARTICLE POPULATIONS. Eviatar, Aharon. College Park, Md., Univ. of Maryland, 1966. 108p.

Thesis.

A Fokker–Planck equation including wave-particle interactions is used to describe the evolution of a distribution of test particles in a magnetic field-free spatially homogeneous plasma. The equation used is that which is obtained by direct linearization of the multispecies Balescu–Lenard–Guernsey kinetic equation in the distribution function of the tenuous test particles. It is shown that this equation can also be obtained by considering the medium to be represented as a gas of uncorrelated test particles. This equation is used to calculate the scattering of a test particle by enhanced electric field fluctuations in plasma containing both suprathermal and thermal electrons. The theory is extended to include the case of ion waves propagating in a current-bearing plasma. Characteristic times for wave–particle scattering in such plasmas are evaluated in terms of the coefficients of the equation and calculated explicitly for some particular distributions. The results are applied to electrons in the Earth's magnetosphere and in the transition zone between the magnetosphere and the interplanetary medium, where the geomagnetic field is weak in the sense that $\Omega^2 \ll \omega_{pe}^2$ ($\Omega = eB/mc$; $\omega_{pe}^2 = (4\pi ne^2/m)$). It is found that interaction with electron plasma oscillations is competitive with whistlers in the scattering of suprathermal electrons and that ion waves are the dominant mechanism for the diffusion of subthermal and thermal electrons across the magnetopause and the Earth's bow shock wave. (Disser. Abstr.)

42121 EFFECT OF ELECTRON TEMPERATURE ON THE EXCITATION OF ELECTROSTATIC ION CYCLOTRON OSCIL-

LATIONS. Levine, Alfred Martin. Princeton, N. J., Princeton Univ., 1966. 74p.

Thesis.

A method has been developed for heating the electrons in a thermally generated alkali plasma by the resonant absorption of electromagnetic waves at the electron cyclotron frequency. Using 0.01 to 1.0 watts of 10 Gc microwave power, the electron temperature was increased from 0.2 to 1.0 eV. Excellent consistency has been found between diamagnetic measurements of plasma pressure, microwave determination of plasma density, and double probe determinations of temperature. The observed temperature increases were in quantitative agreement with computations which consider the heat loss by thermal conduction. The heating method was used to study the electron temperature dependence of the current required to excite electrostatic ion cyclotron oscillations. Contrary to the previously accepted theory of Rosenbluth, the critical current was found to increase with increasing electron temperature. A new theory is presented which properly predicts the magnitude and electron temperature dependence of the current required to excite the oscillations. (Disser. Abstr.)

42122 STRUCTURE OF THE CURRENT SHEET IN A PINCH DISCHARGE. Burton, Rodney Lane. Princeton, N. J., Princeton Univ., 1966. 145p.

Thesis.

The structure of a propagating current sheet in a cylindrical pinch discharge in argon is studied experimentally and analytically. The azimuthal magnetic field, $\vec{B}_\theta$, is mapped throughout the discharge, yielding patterns of current density, $\vec{j}$. From an inventory of the $\vec{j} \times \vec{B}$ distributions, it is deduced that the bulk of the gas is accelerated to the current sheet velocity. The patterns of radial electric field, E_r, normal to the current sheet, are mapped with a coaxial floating double probe. Based on a one-dimensional, constant compression model, the E_r field appears to be of sufficient magnitude to allow conduction of all axial current by electrons in collisionless $\vec{E}_r \times \vec{B}_\theta$ drift. This field is not strong enough, however, to accelerate ambient ions to the sheet velocity, suggesting that gas dynamic forces also participate in the interaction. This model also identifies ohmic heating in the sheet with the product of radial ion current density and E_r. Comparative measurements in neon, argon, and krypton, keeping the ambient mass density constant, indicate that this ohmic heating decreases with increasing molecular weight. (Disser. Abstr.)

Production of Plasma

42123 (AD-645119) ELECTROTHERMALLY ACCELERATED PLASMA JETS. Final Technical Report, June 1, 1965-May 31, 1966. Ducati, Adriano C. (Giannini Scientific Corp., Santa Ana, Calif.). Sept. 30, 1966. Contract AF49(638)-1572. 105p. (AFOSR-66-2726). CFSTI.

Experimental and theoretical results are presented on the performance characteristics of the low pressure arc jet operated with hydrogen. Thermal and thrust power efficiency have been measured for up to 20-kG applied magnetic fields and various electrode configurations and specific impulses. The thermal efficiency is insensitive to magnetic field strength and specific impulse in the high range of specific impulse. Thrust efficiency shows a dependence on the magnetic field for operating conditions which produce values of the Hall parameter much larger than unity, but this may be due to the much discussed spurious interactions of the arc with the environment. The efficiencies show a definite and fairly regular increase with increasing arc chamber pressure. Tests have been conducted which demonstrate qualitatively the effect of the applied field on the arc current distribution. A good two-parameter fit of thermal efficiency data is given, and an analytical model for the thermal losses is partially developed. Explicit expressions for the torque on the arc jet flow are obtained for two classes of idealized current distributions. An inequality is derived which places a lower bound on the torque for a given applied magnetic field and electrode configuration. (auth) (TAB)

42124 (RT/FI-(67)9) FORNACI AD ALTA TEMPERATURA PER LA FORMAZIONE DI PLASMI ALCALINI IN EQUILIBRIO TERMODINAMICO. (High-Temperature Furnace for Production of Alkali Plasma in Thermodynamic Equilibrium). Garosi, F.; Neri, A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1967. 30p. (In Italian). Dep.

To evaluate the screening efficiency of the described furnaces the derivation of the radiative balance of heat sources is outlined. Two different systems are described for heating to high temperatures (1500 to 2500°K) a furnace designed for the production of alkali plasmas by thermal ionization on incandescent containers and in thermodynamic equilibrium. (auth)

42125 PLASMA PRODUCTION BY A HIGH-POWER Q-SWITCHED LASER. Sucov, E. W.; Pack, J. L.; Phelps, A. V.; Engelhardt, A. G. (Westinghouse Research Labs., Pittsburgh). Phys. Fluids, 10: 2035-48(Sept. 1967).

Studies have been made of the confinement in a magnetic mirror of plasmas produced by focusing a Q-switched laser beam on aluminum disks, foils, and spheres. High speed photographs show that, in the absence of a confining magnetic field, the plasma generated from ball targets is roughly symmetrical whereas one component of the plasma generated from flat targets is asymmetric and moves toward the laser with a velocity of about 10^7 cm/sec. A second component which is more nearly symmetric expands with a velocity of approximately 2×10^6 cm/sec. The expansion velocities are not appreciably reduced in a 14-6-14 kG mirror field. However, the duration of the luminosity from a slower constituent of the plasma increases from 1 μsec to about 5 μsec and microwave interferometer measurements show an electron density of about 5×10^{11} cm^{-3} at times as late as 50 μsec. Electrostatic probes verify that the maximum expansion velocity corresponds to an ion kinetic energy of about 1.4 keV. Time integrated spectra of the plasma show lines from Al III. Microwave attenuation measurements lead to an apparent electron temperature of the order of 0.03 eV at times later than 1 μsec. Analysis of microwave data shows that radial density gradients probably exist in some plasmas. (auth)

42126 ION EMISSION FROM LASER-PRODUCED PLASMAS. Koopman, David W. (Maryland Inst. of Technology, Bethesda). Phys. Fluids, 10: 2091-3(Sept. 1967).

Energy and time-of-flight measurements on ions from LiH and LiD plasmas, using an electrostatic analyzer, have shown fast ions traveling ahead of the high-density plasma boundary observable with probes and photography. (auth)

42127 PLASMA ACCELERATION IN AN ELECTRICAL DISCHARGE BY THE SELF-INDUCED MAGNETIC FIELD. Malliaris, A. C. (Avco Corp., Wilmington, Mass.). J. Appl. Phys., 38: 3611-19(Aug. 1967).

An electrical discharge is considered between two electrodes arranged axisymmetrically in the absence of an external magnetic field. Discharge currents are used up to 2500 A in a steady state and in the presence of a nitrogen flow rate of the order of a few hundred milligrams per second. The interaction of the discharge with its self-induced magnetic field is examined and the importance of magnetoplasmadynamic effects in the acceleration of plasma is determined quantitatively. After a brief consideration of the analytical background several experiments are discussed and the corresponding results are analyzed. It has been determined that the self-magnetic field makes a substantial contribution, as high as 60% or higher in certain cases, to the acceleration of plasma. The particularly effective mechanism in these experiments seems to be the self-induced compression of the plasma in the discharge in front of the cathode. Further experimental results are presented from measurements of the momentum flux and of the velocity in the plasma flow. These measurements are constructively correlated with the forces which accelerate the plasma. (auth)

42128 FAST-RANDOMIZATION PHENOMENA IN AN UNSTABLE PLASMA-SAC CONFIGURATION. Hoyaux, M. F.; Williams, E. M. (Carnegie Inst. of Tech., Pittsburgh). Contract AT(30-1)-3100. J. Appl. Phys., 38: 3630-4(Aug. 1967).

Results of a detailed experimental study of conditions in and about a plasma sac formed at a constriction in a discharge column are reported. An evolution of phenomena is initiated by the application to the discharge column of a high-current pulse, which in combination with a low steady-state pressure produces a marked depletion of neutral-gas atoms. This depletion causes a high voltage drop to develop across the double sheath which bounds the plasma sac and a resultant high acceleration of the electron gas toward the constriction. The Mach number increases; when it approaches a critical value, of the order of or slightly greater than unity, extremely rapid randomization of the electron velocities ensues. Concurrently, the Mach number is stabilized near unity over a substantial range of increase of the voltage drop which is accelerating the electrons. A tentative explanation is included. (auth)

42129 THEORETICAL STUDY OF THE ENTRAPMENT OF IONS AND ELECTROSTATIC SHOCK WAVES IN A HIGH FREQUENCY PLASMA ACCELERATOR. Canobbio, Ernesto; Collet, Roland (Centre d'Etudes Nucleaires, Saclay, France). Compt. Rend., Ser. A and B, 264: 1485-8(May 29, 1967). (In French).

The axial electrostatic field which is developed in the resonance zone of a mixed structure with electron resonance and the ion entrapment resulting are studied. (tr-auth)

42130 PHYSICAL SIGNIFICANCE OF THE ASYMPTOTIC STABILITY OF THE IONIZATION WAVE EQUATION. Fuchs, Vladimir (Charles Univ., Prague). Beitr. Plasmaphys., 7: 1-10(1967). (In German).

In the homogeneous system of partial differential equations of the layered wave theory, a source function Q(x,t) expressing the effect of a local perturbation of the plasma was introduced. A law was formulated and proved on the asymptotic stability of this system. In the stable regime the theory constructed on the (S) system is without contradiction and on this system a theory of artificially produced and moving layers can be synthesized. (tr-auth)

42131 STABILITY ANALYSIS OF A LINEAR HALL CURRENT ION ACCELERATOR. Garrison, George Walker Jr. Raleigh, N. C., North Carolina State Univ., 1966. 73p.

Thesis.

A normal mode analysis is used to investigate the stability of a screw type perturbation observed in the Hall current ion accelerator. Due to the similarities between this instability and that observed in the positive column discharge, the governing conservation equations are taken to be those for a weakly ionized collision-dominated plasma which are normally used in the description of the positive column. The system has been found to be stable to this perturbation in the absence of an axial magnetic field, with or without a center core. When the axial magnetic field is included, the system is unstable to a right-handed helical perturbation (m = –1) even for small values of the axial magnetic field. The radial magnetic field has a stabilizing effect on the system. However, for a certain range of parameter values, no neutral stability point is found, and the system is unstable for all values of electric and magnetic fields investigated. (Disser. Abstr.)

Stability of Plasma

42132 (AD-645148) PARTICLE ASPECT ANALYSIS OF DRIFT WAVE INSTABILITY. Research Report. Terashima, Y. (Nagoya Univ. (Japan). Inst. of Plasma Physics). Nov. 1966. 18p. CFSTI.

The physical mechanism of drift wave instability is studied from the particle point of view by following the method used by Dawson in his theory of Landau damping. The plasma particles are divided into two groups, resonant particles and nonresonant particles. Assuming that a drift wave starts initially while resonant particles are undisturbed, the trajectories of the particles are computed within the framework of linear theory. Such a drift wave of longitudinal mode is considered that propagates obliquely to a static magnetic field and in the plane normal to density gradient. (auth) (TAB)

42133 (D-1-82-0626) FINITE AMPLITUDE INSTABILITIES IN WEAKLY IONIZED GASES AND SOLIDS. Johnson, Roy R. (Boeing Scientific Research Labs., Seattle, Wash. Plasma Physics Lab.); Holter O. (Olso Univ. (Norway). Fysisk Institutt). June 1967. 101p.

A study of macroscopic instabilities which can have a finite amplitude is presented. Beginning with the helical instability for the positive column in a longitudinal magnetic field as derived from a perturbation analysis, the theory is generalized to include the region of magnetic fields where the amplitude of the instability can no longer be considered small relative to the time-averaged background plasma density. The theory of the finite amplitude helical instability includes calculations of the hysteresis effect, frequency and wavelength of the helix, and the internal magnetic field. The conditions whereby the finite amplitude helical instability can cause the excitation of higher modes will then be investigated. Experimental evidence of the behavior of the helical instability is presented for comparison with the theory. The theory for the helical instability in solid-state plasmas is then developed. This includes a study of the behavior of plasmas caused by injection and impact ionization in addition to the thermal carriers. Finally, experimental results of the helical instability observed in semiconductor plasmas is presented. (auth)

42134 EFFECT OF MAGNETIC SHEAR ON PLASMA INSTABILITIES. Drummond, W. E.; Gentle, K. W. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Fluids, 10: 2021-5(Sept. 1967).

The magnetic shear is introduced directly in the basic plasma equation to provide a new formulation of the effects of shear on waves in a plasma. The linearized Vlasov equation is solved in the natural coordinate system that shears with the magnetic field. Instead of an algebraic dispersion relation for waves, a differential equation in k-space results. The solutions of this equation must be explored to determine effects of shear on plasma waves. An approximate solution is obtained for the drift-wave instability and the criterion for shear stabilization is calculated. The criterion is close to previous results, but more general stable modes may be considered. (auth)

42135 STABILIZATION OF A STELLARATOR PLASMA BY FINITE-LARMOR-RADIUS AND ION-ION-COLLISION EFFECTS. Ellis, R. A. Jr.; Bol, K.; Stix, T. H. (Plasma Physics Lab., Princeton Univ., N. J.). Phys. Fluids, 10: 2095-6(Sept. 1967).

The magnetic field, B_c, for onset of nonreproducible fluctuations in stellarator afterglows varies with ion mass as $m_i^{0.44}$. For ion viscous stabilization of drift waves $B_c \sim m_i^{\frac{1}{2}}$; for finite ion Larmor radius or ion cyclotron frequency stabilization, $B_c \sim m_i^{\frac{1}{2}}$. (auth)

42136 STABILITY OF GUIDING-CENTER PLASMAS IN A SHEARED MAGNETIC FIELD. Kadish, Abraham (Univ., of Wisconsin, Madison). Phys. Fluids, 10: 1614-18(Aug. 1967).

The stability of a plasma in a magnetic field with nonuniform orientation is investigated in the guiding center limit. Conditions sufficient for exponential stability are derived which are local analogs of those which have been obtained for uniform plasma equilibria. The existence of growth rates slower than exponential ones is considered. (auth)

42137 NONLOCAL DRIFT MODES IN CYLINDRICAL GEOMETRY. Chen, Francis F. (Princeton Univ., N. J.). Phys. Fluids, 10: 1647-51(Aug. 1967). (MATT-531).

Numerical computations are given for resistive drift instabilities of a plasma in a conducting cylinder, for cases where the usual WKB analysis fails because the waves are not localized radially by shear in the drift velocity. The finite boundary conditions are found to have a stabilizing effect on flute modes ($k_{||} = 0$) and a destabilizing effect on drift modes ($k_{||} \neq 0$). The growth rate for drift waves is more than three times larger than that given by "local" dispersion relations. These computations are particularly relevant to oscillations in cesium and potassium plasmas. (auth)

42138 GRAVITATIONAL INSTABILITY OF A ROTATING ANISOTROPIC PLASMA. Bhatia, P. K. (Univ. of Jodhpur, India). Phys. Fluids, 10: 1652-3(Aug. 1967).

Gravitational instability in an anisotropic plasma has been studied to include the effect of rotation. It is shown that the stability criterion is dependent upon rotation as well as magnetic field. (auth)

42139 INCOMPRESSIBLE RESISTIVE TEARING INSTABILITY IN THE HARD-CORE PINCH. Hosking, R. J. (Univ. of Western Ontario, London, Can.). Phys. Fluids, 10: 1654-62(Aug. 1967).

Calculations for the finite conductivity "tearing" instability in the hard-core pinch with constant applied axial magnetic field are described. Cylindrical effects in the "outer" region, where the plasma remains effectively coupled to the magnetic field, are fully allowed for through a numerical solution of the boundary value problem. It is seen that there is quite good agreement with recent experimental measurements on the hard-core configuration, even though plasma compressibility is ignored. In particular, the fact that the m = 1 mode is not generally the fastest growing is accounted for by the use of cylindrical geometry in the outer region. A second result is that an increase in the ratio of azimuthal to magnetic field appears to be a somewhat better means of stabilization against "tearing" modes than one might have anticipated. A criterion for the validity of the plane approximation in the "outer" region is developed analytically. (auth)

42140 STATISTICAL FRAMEWORKS FOR WEAK PLASMA TURBULENCE. Davidson, R. C. (Univ. of California, Berkeley). Phys. Fluids, 10: 1707-13(Aug. 1967).

A hierarchy is constructed describing the time evolution of correlations due to collective interactions in a weakly turbulent, spatially uniform ensemble of Vlasov plasmas. It is shown that this "Vlasov hierarchy" is identical to the Bogolyubov–Born–Green–Kirkwood–Yvon (BBGKY) hierarchy for irreducible correlations in a spatially homogeneous plasma, provided the effects of single particle encounters are deleted from the BBGKY framework. In addition, the random phase approximation used in conventional treatments of weak plasma turbulence is shown to be automatically embodied by such a formalism. Upon ordering the system of equations in the weak turbulence parameter, $\langle E^2 \rangle / nmv_{th}^2$, the questions of closure and time validity are examined. (auth)

42141 LOW-FREQUENCY INSTABILITY OF AN INHOMOGENEOUS WEAKLY IONIZED PLASMA IN CROSSED ELECTRIC AND INHOMOGENEOUS MAGNETIC FIELDS. Kopecky, V. (Inst. of Plasma Physics, Prague). Czech. J. Phys., 17: 506-15(1967).

The drift dissipative instability that arises in a weakly ionized inhomogeneous plasma in crossed electric and magnetic fields is discussed. The potential perturbations are studied in the WKB (Wentzel–Krammers–Brillouin) approximation, i.e., for $k_\perp \gg \kappa = d \ln n_0/dx$. The critical magnetic field, beyond the value of which

the plasma is again stable against the studied perturbations, is computed. The effect of the inhomogeneity of the magnetic field modeled by a gravitational field is analyzed and the effect of a magnetic field, growing in the direction opposite to that of the plasma density, is pointed out. Under certain circumstances similar phenomena also arise in the current-convective instability. (auth)

42142 CYCLOTRON INSTABILITIES OF A TWO-COMPONENT ELECTRON PLASMA. Jungwirth, K. (Inst. of Plasma Physics, Prague). Czech. J. Phys., 17: 498-505(1967).

A study is made of instability at frequencies close to the electron cyclotron frequency ω_B and its multiples, subject to the presence of two different groups of electrons. It is shown that a mixture of hot and cold electrons ($\omega_{ph}^2 \ll \omega_{pc}^2$) in the region of frequencies $\omega \approx s\omega_B$, $s \geqq 2$ can be unstable with respect to waves of the flute type ($k_z = 0$) with maximum increment $\gamma_{max} \approx (\omega_{ph}/\omega_{pc}) \cdot \omega_B$, if there exists an interval of transversal velocities $v_\perp$ in which $\partial F/\partial v_\perp > 0$. When the curvature of the magnetic field is taken into account, even waves with $\omega \approx \omega_B$ can be unstable in such a plasma. The effect of spatial inhomogeneity of the hot component on flute-type instability and on two-beam cyclotron instability is also examined. (auth)

42143 CONSTANTS OF THE MOTION AND MICROSCOPIC STABILITY OF PLASMAS. Voelk, Heinrich J. (Massachusetts Inst. of Technology, Cambridge). Phys. Fluids, 10: 1697-1706(Aug. 1967).

The possibility of sidestepping the direct solution of the Vlasov equation in order to obtain information about the stability of a plasma by employing certain constants of the motion is discussed. For plane equilibria a large set of conservation laws is derived in the electrostatic approximation, including those for the total energy and momentum of the system. For some special equilibria the positive-definiteness of the energy yields a (well-known) sufficient stability criterion. The extension of these criteria to more general cases with the help of the more general class of constants is discussed. In the one-dimensional homogeneous case without magnetic field one thus can establish an "energy principle" for the Vlasov equation. An earlier attempt by Oberman and Dawson using energy and momentum conservation only is discussed in this context. However, the generalization even to the corresponding three-dimensional case turns out to be impossible. It is concluded that, except for the plasma equilibria mentioned, even the most general constants of the motion known up to now do not lead to stability criteria of the Liapounov type. (auth)

42144 MODEL EQUATIONS FOR STRONG TURBULENCE IN A VLASOV PLASMA. Orszag, Steven A. (Inst. for Advanced Study, Princeton, N. J.); Kraichnan, Robert H. Phys. Fluids, 10: 1720-36(Aug. 1967).

Approximate integrodifferential equations are proposed to determine the ensemble mean and covariance of the particle-distribution function for the one-species self-consistent Vlasov problem and for acceleration of particles in a prescribed stochastic electric field. The approximations correspond to the direct-interaction approximations for incompressible Navier-Stokes turbulence and turbulent convection. The final equations are exact statistical descriptions of model dynamical systems. This assures realizability of the covariance and conservation of energy, momentum, and probability. In addition, the model representation implies irreversible relaxation of the initial distribution. The relation of the proposed approximations to quasilinear theory and to the strong-turbulence theories of Mikhailovskii, Kadomtsev, and Dupree is analyzed. The diffusion limit and short-time limit of the stochastic-acceleration model are examined by an adaptation of Roberts' analysis for turbulent convection. (auth)

42145 STABILITY OF A RELATIVISTIC MAGNETO-GAS-DYNAMIC HALF-JET. Lessen, Martin; Zien, Hwa M. (Univ. of Rochester, N. Y.). Phys. Fluids, 10: 1752-5(Aug. 1967).

The stability of a relativistic half-jet of infinitely conducting, inviscid, compressible fluids with imbedded magnetic fields is considered. The general dispersion relation and eigenvalue equation are derived from the theory of special relativity. Numerical results show that the magnetic fields have a stabilizing effect and the effect is comparatively greater than that of an increase of the speed of sound. Moreover, disturbances in the vicinity of neutral oscillations correspond to supersonic, outgoing waves. (auth)

42146 PLANE MAGNETOHYDROSTATIC EQUILIBRIUM WITH INNER FIELD. Gorenflo, Rudolf; Schlueter, Arnulf (Institut fuer Plasmaphysik GmbH, Garching, Ger.). Z. Angew. Math. Mech., 47: 145-53(Apr. 1967). (In German).

Conditions for static equilibrium are formulated for two-dimensional analogs of toroidal plasma configurations with purely meridional electric currents. It is shown by examples that these conditions can be satisfied. The magnetic field inside the plasma need not be zero. Two cases are considered: (1) inside the plasma no currents flow and the pressure p is constant, but $\ll B^2$; (2) currents flow inside the plasma as well, the pressure being variable. (auth)

42147 WEAK TURBULENCE IN A HOMOGENEOUS PLASMA. Davidson, Ronald William Crosby. Princeton, N. J., Princeton Univ., 1966. 143p.

Thesis.

The problem of weak plasma turbulence is considered within the framework of the B-B-G-K-Y hierarchy of equations for a fully ionized, magnetic field-free, spatially homogeneous, ensemble of slightly unstable (in velocity space), multispecies, plasmas. (Disser. Abstr.)

42148 STUDY OF THE INTERCHANGE INSTABILITY IN ELECTRON-CYCLOTRON-HEATED PLASMAS. Christy, Edmund Harris Jr. New Orleans, Tulane Univ., 1966. 106p.

Thesis.

Energetic plasma confined in magnetic mirror systems is unstable to low frequency drift waves propagating in the azimuthal direction, commonly referred to as the flute or interchange instability. The instability results in abnormally high losses of high energy particles and may be suppressed by the addition of cold plasma to the system. The relative amount of cold plasma required for stabilization is a point of dispute both theoretically and experimentally. A series of experiments have been performed on a hot electron plasma produced in a magnetic mirror configuration by electron cyclotron resonance heating. Using the Physics Test Facility of the Oak Ridge National Laboratory the flute instability has been observed and measurements of the phase velocity of the wave made. The l = 2 mode was found dominant in this machine but higher order flutes were also observed. The shorter wavelength modes appear to be the first to grow and persist even when the longer wavelengths are damped. Measurements of the bremsstrahlung emission permit determination of the energetic electron energy distribution and density. The phase velocity of the flutes corresponds closely to the electron gradient B drift velocity. Interferometric measurements of the density of the cold plasma at the threshold of the instability show it to be approximately 5% as dense as the energetic component. This figure is compared to representative theoretical treatments and found to be in reasonable agreement with a simplified finite-length dielectric plasma model. (Disser. Abstr.)

Thermonuclear Processes

42149 EVIDENCE FOR A THERMONUCLEAR REACTION IN A θ-PINCH PLASMA FROM THE SCATTERING OF A RUBY LASER BEAM. Ramsden, S. A.; John, P. K.; Kronast, B.; Benesch, R. (National Research Council of Canada, Ottawa). Phys. Rev. Lett., 19: 688-9(Sept. 18, 1967).

Neutron detection measurements were carried out on a 100-kJ θ pinch having a magnetic field of 72 kG, a quarter period of 6 μsec, a coil of length 37.5 cm and diameter 6.5 cm, an applied reverse B_z field of 3.5 kG, and a filling pressure of ~60 μ of deuterium. The experimental apparatus and results are described. (M.O.W.)

Shielding

Refer also to abstracts 40936, 41177, 41757, 42239, 42487, and 42542.

42150 (NP-16824) DATA COMPILATION AND EVALUATION OF SPACE SHIELDING PROBLEMS. VOLUME IV. LSVDC4 PROGRAM SYSTEM. Hill, C. W.; Ritchie, W. B.; Simpson, K. M. Jr. (Lockheed-Georgia Co., Marietta). Feb. 1967. Contract NAS-8-11164. 110p. (ER-7777(Vol.4)). CFSTI.

The LSVDC4 Program system permits the evaluation of trapped radiation hazards and solar flux event radiation hazards to critical organs and sensitive equipment within a complex geometry space vehicle. Data preparation and checking are simplified to a point consonant with system flexibility. Mathematical models of physical configurations and processes are chosen which permit rapid computation with reasonable accuracy. The numerical techniques employed do not significantly degrade the accuracy permitted by the mathematical models. (auth)

42151 CALCULATION OF NEUTRON SCATTERING AND THERMAL NEUTRON SPECTRA IN POLYETHYLENE USING THE NELKIN KERNEL. Keinert, J.; Pucher, M. (Institut fuer Kernenergetik, Stuttgart). Atomkernenergie, 12: 279-84(1967). (In German).

The parameters of polyethylene for the Nelkin kernel are calculated in the following approximations for the dynamics of the proton

motion: internal vibrations of the free CH_2 group, torsional oscillations of the CH_2-group, and free translations of the CH_2 group. The computer program for the Nelkin-kernel takes into account three oscillators. Numerical results of scattering cross sections and of thermal neutron spectra in infinite polyethylene media are compared with experiments and with calculations with parameters given by Goldman–Federighi and by Koppel–Young. The thermal neutron spectra in the center of a Siemens-Unterrichts-Reaktor are calculated and compared with a combined Maxwell and 1/E spectrum. The parameters for the combined Maxwell and 1/E spectrum are found experimentally by an integral method. (auth)

42152 NEUTRON FLUXES IN CONCRETE DUCTS ARISING FROM INCIDENT THERMAL NEUTRONS: CALCULATION AND EXPERIMENT. Maerker, R. E.; Muckenthaler, F. J. (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 29: 444-54(Sept. 1967).

Monte Carlo calculations, employing the albedo concept, were carried out to determine the thermal-neutron flux distributions along the centerlines of a straight, a two-legged, and a three-legged square open concrete duct for a particularly demanding source geometry. The neutrons entering the duct were of thermal energy. The calculations used differential angular albedo data for concrete which have been reported previously. A comparison of the results of the calculations with those from a geometrically similar experiment shows good agreement and places on a firm foundation the concept of treating the thermal-neutron duct transmission problem as a reflection phenomenon at a point that is describable by the differential albedo properties of the walls. (auth)

52153 DISCUSSION ON: "SHIELDING PROPERTIES OF THE UPb_3 INTERMETALLIC COMPOUND" BY JAMES S. MOSER AND ALFRED F. ROHACH. Smith, R. (Lead Development Association, London). Nucl. Eng. Design, 5: 514-15(July 1967).

Several criticisms of the previous article are given: the primary ones having to do with the faults found with lead as a shielding material. Some criticisms of UPb_3 as a shielding material are presented. (M.H.R.)

42154 BUILDUP FACTORS FOR LOW ENERGY γ-RADIATION. Krueger, F. W. (VEB Kombinat Kernenergetik, Berlin). Kernenergie, 10: 194-5(June 1967). (In German).

Methods are described for the determination of buildup factors for low-energy photons. With these methods the dose buildup factors in water, aluminum, iron, and lead were calculated for photons with energies below 0.5 MeV. The results are given in tables. (auth)

42155 SERVICE BEHAVIOR OF CONCRETE FOR RADIATION SHIELDING. Lott, J. L.; Kesler, C. E. (Univ. of Illinois, Urbana). Mater. Res. Stand., 7: 375-82(Sept. 1967).

The behavior of portland cement concrete as a polyphase material is reviewed. Concrete for radiation shielding is subjected to stresses caused by structural loads and volume changes caused by moisture exchange and thermal gradients and cycling. Distress of concrete is associated with the incompatibility of the various phases of hardened concrete. Microcracks develop at the highly stressed paste–aggregate interface and propagate through the paste. (auth)

Solid-State Physics

Refer also to abstracts 41151 and 42278.

42156 (AERE-R-5467) LONGITUDINAL OPTIC MODES IN MAGNESIUM OXIDE. Buckland, R. J.; Saunderson, D. H. (Atomic Energy Research Establishment, Harwell (England)). June 1967. 9p. Dep. CFSTI. UK 2s. 6d.

The frequencies of longitudinal optic modes propagating along three symmetry directions in magnesium oxide were measured on the DIDO triple-axis neutron spectrometer. The results are compared with dispersion curves calculated using an interionic force model fitted to neutron inelastic scattering data on lower-frequency modes. (auth) (UK)

42157 (UCRL-5304) COMPUTATION OF X-RAY ABSORPTION CORRECTIONS ON THE IBM 650. Sands, Donald E. (California Univ., Livermore. Lawrence Radiation Lab.). July 1958. Contract W-7405-eng-48. 25p. Dep. CFSTI.

A method for machine computation of the absorption of x rays by a crystal of arbitrary convex shape was applied to the programming of the IBM 650 to compute the absorption corrections for the equatorial reflections of a crystal of constant convex-polygon cross section. (M.H.R.)

42158 (UCRL-17633) A FIELD ION MICROSCOPE INVESTIGATION OF RADIATION DAMAGE IN IRIDIUM BOMBARDED WITH 10 MeV PROTONS. Petroff, Pierre (California Univ., Berkeley. Lawrence Radiation Lab.). July 1967. Contract W-7405-eng-48. 101p. Dep. CFSTI.

Thesis.

The aim of the investigation was a better understanding of radiation damages and of their annealing behaviors in face-centered-cubic metals. For this purpose well-annealed iridium specimens were irradiated at 5°K with 10-MeV protons, "in situ" a field ion microscope attached to the 88-in. cyclotron at Berkeley. Because of the atomic scale resolution of the field-ion microscope, point defects and their clusters were directly observed at the surface and in the bulk of the irradiated specimens. The low-temperature surface damage caused by bombardment with 10-MeV protons was mostly composed of ejected surface atoms. The larger surface damage observed during irradiation with the imaging field applied to the specimen has been related to the lowering in the binding energy of the surface atoms when the electrostatic field is applied to the specimen. The interpretations of the contrast effects associated with some of the observed defects are also discussed in detail. Interstitials have been associated with extra-bright dots popping up to the surface upon an increase of the field applied to the specimen. Pairs of extra-bright dots popping up to the surface have been associated with single interstitials as well as diinterstitials. The annealing behavior of the defects, as observed from the surface changes and the variations in the bulk interstitial concentration, showed that both annealing stages I and III correspond to interstitial migration. However the limitations of the field ion microscope technique did not permit a decision as to the existence of two different types of interstitials associated with stage I and stage III. The effects of the irradiation temperature were also investigated. The large voids and dislocation loops observed in the specimens irradiated at room temperature suggested both a vacancy migration process and a different formation mechanism for the damage. (auth)

42159 (USNRDL-TR-67-80) CHARGED PARTICLE TRACKS IN POLYMERS NO. 4: CRITERION FOR TRACK REGISTRATION. Benton, Eugene V. (Naval Radiological Defense Lab., San Francisco, Calif.). July 10, 1967. 24p. CFSTI.

A new criterion for track registration in polymer charged-particle detectors is proposed. Based on the concept of the restricted energy loss rate, it indicates that only energy transfer collisions of 1.0 ± 0.2 keV and less are important in track formation. For track registration in cellulose nitrate and Lexan, a charged particle must have a restricted energy-loss rate of 1.1 and 3.7×10^3 MeV cm^2/g respectively. This threshold appears to be sharp in both materials. (auth)

42160 (USNRDL-TR-67-83) RADIATION EFFECTS IN THERMOELECTRICS. 2. PERMANENT AND QUASI-PERMANENT EFFECTS OF PILE BOMBARDMENT ON SEVERAL COMPOUND SEMICONDUCTORS. Winslow, John W. (Naval Radiological Defense Lab., San Francisco, Calif.). July 18, 1967. 74p. CFSTI.

Radiation effects on the thermoelectric properties of several compound semiconductors have been observed experimentally for exposure doses up to 2.3×10^{19} fast (E > 1 MeV) neutrons/cm^2. Results are reported for the following materials: PbTe; $Ge_{.95}Bi_{.05}Te$; Ag_2Se; n- and p-types of a Ge–Si alloy; $(GeTe)_{80\%}(AgSbTe_2)_{10\%}$; CoSi; n- and p-types of commercial grade Bi_2Te_3; and single-crystal, stoichiometric Bi_2Te_3. Properties measured were Seebeck coefficient (S), electrical resistivity (ρ), and thermal diffusivity (α). The effects observed ranged from an apparently simple case of change in majority charge carrier concentration due to transmutations, to rather complicated cases in which the behavior of the variables was strongly influenced, both for the better and for the worse, by post-irradiation, thermally activated processes, e.g., annealing. In some cases, no effects at all were found. Post-annealing values of the radiation-induced changes found in the observed variables were used to calculate the corresponding changes to be expected in the thermoelectric figure of merit (z) of each material, using the relation $z = S^2/\rho_o c_p \delta$, where c_p is specific heat and δ is density, under the assumption that the product $c_p \delta$ remained constant. These changes in z ranged from a decrease of about an order of magnitude, to about a four-fold increase, in the pre-irradiation value of z. Some indications that substantial improvements in z for the Ge–Si alloys may be possible through appropriate sequences of irradiation and post-irradiation thermal treatment, were seen. A brief review of the field, aimed at providing suitable background for nonspecialist readers, and recommendations for future Navy activity in this technological area, are given. (auth)

42161 SYSTEMATIC EXTINCTIONS OF REFLECTIONS IN THE COHERENT MAGNETIC SCATTERING OF SLOW NEUTRONS, DUE TO THE PRESENCE OF SYMMETRY AND ANTI-SYMMETRY ELEMENTS IN COLLINEAR MAGNETIC MATERIALS. Ozerov, R. P. (Inst. of Physical Chemistry, Moscow). Sov. Phys.-Cryst. (Engl. Transl.), 12: 199-208(Sept.-Oct. 1967).

Translated from Kristallografiya, 12: 239-51(Mar.-Apr. 1967).

The conditions for systematic extinctions of magnetic reflections due to the presence of symmetry (and/or antisymmetry) elements in collinear magnetic materials are considered. The results are presented in the form of a table. (auth)

42162 ELASTICITY OF QUARTZ IRRADIATED WITH FAST NEUTRONS. Zubov, V. G.; Ivanov, A. T. (Moscow State Univ.). Sov. Phys.-Cryst. (Engl. Transl.), 12: 313-14(Sept.-Oct. 1967). Translated from Kristallografiya, 12: 365-6(Mar.-Apr. 1967).

The elastic properties of two α quartz specimens subjected to two different neutron doses considerably in excess of 2×10^{19} n/cm^2 were investigated. Measurements were made by the method of diffracting light on ultrasonic waves excited in the specimens with a quartz oscillator. The error was 1 to 2%. The results confirmed the observation of other investigators that the values of the elastic moduli in the range stated did not generally tend toward the modulus values of the fused quartz into which α quartz is transformed after a dose of about 2×10^{20} n/cm^2. Comparison with the results of other investigators also indicated that numerical values of the elastic constants of quartz irradiated under different conditions will be similar if they are compared for identical density values. (A.G.W.)

42163 MAGNETIC SUSCEPTIBILITIES OF SOME RARE EARTH–ZINC (RZn_2) INTERMETALLIC COMPOUNDS. Deb Ray, D. K.; Ryba, Earle; Mulay, L. N. (Pennsylvania State Univ., University Park). Contract AT(30-1)-3560. J. Appl. Phys., 38: 3459-60(Aug. 1967). (NYO-3560-5(Rev.)).

Data on the paramagnetic susceptibilities of the rare-earth–zinc intermetallic compounds, $NdZn_2$, $SmZn_2$, $GdZn_2$, $TbZn_2$, $HoZn_2$, and $YbZn_2$, in the 77 to 300°K region, are presented. The susceptibility obeys the Curie–Weiss law for all the compounds except $YbZn_2$. $YbZn_2$ has a susceptibility which is negative at room temperature but positive at lower temperatures. The data obtained from the paramagnetic region for the other compounds, except $GdZn_2$, yield effective magnetic moments in agreement with the theoretical moments for the corresponding free tripositive ions. The reason for the anomalous value for $GdZn_2$ is not understood. (auth)

42164 THERMOLUMINESCENCE AND COLOR CENTERS OF GAMMA-IRRADIATED VITREOUS AND CRYSTALLINE SODIUM METAPHOSPHATE. Bettinali, Carlo (CNEN, Rome, Univ., Rome). Z. Phys. Chem. (Frankfurt), 55: 234-42(Aug. 1967).

The nature of color centers formed in vitreous and crystalline sodium metaphosphates by irradiation with gamma rays was studied by means of diffused refractance spectra, electron spin resonance absorption, thermoluminescence glow curves, and spectral composition of glow curves. The reaction of color centers formation in which cations diffuse through the lattice was less favored in crystalline samples. Activation energies were estimated from thermoluminescence glow curves. The thermoluminescence mechanism is probably that one caused by electrons coming from a single level recombining with centers of different depths having different cross sections. (auth)

42165 LATTICE CONSTANTS AND DENSITY CHANGES IN NEUTRON IRRADIATED LiF. Kapfhammer, W.; Peisl, H.; Waidelich, W. (Technische Hochschule, Darmstadt, Ger.). Z. Angew. Phys., 23: 249-53(1967). (In German).

Lattice disorder in neutron-irradiated LiF crystals was investigated by combined measurements of lattice parameter and mass density change. Up to an irradiation dose of 10^{17} neutrons/cm^2 equivalence of relative lattice parameter and density change was found. The defects created are of Frenkel type. For a higher dose also Schottky-type defects were formed. The defects disappear during isochronal and isothermal annealing programs in a wide annealing stage between 150 and 420°C. The lattice parameter change goes to zero, the density of the annealed crystals is higher than the density of the unirradiated crystals. (auth)

42166 TRANSMUTED-CENTER FERMI-LEVEL SPECTROSCOPY IN SLOW-NEUTRON-IRRADIATED ZnO. Lindeberg, G. K. (3M Co., St. Paul). J. Appl. Phys., 38: 3651-9(Aug. 1967).

Measurements of resistivity vs time and temperature between 70 and 300°K were made on an n-type ZnO crystal which had been irradiated in a slow neutron-integrated flux of 4.1×10^{20} cm^{-2}. During the course of the measurements, the crystal was transmutation-doped by the 245-day half-life decay of ^{65}Zn to ^{65}Cu. ^{69}Ga was also present in the crystal, as the daughter of the shorter-lived ^{69}Zn. The data were treated using a phenomenological theory of transmuted-center Fermi-level spectroscopy (TCFLS) based upon assumptions of sample homogeneity, electron-system equilibrium, filled transmuted acceptors, and linear relation at constant temperature between Fermi level and $\log_{10}$ resistivity. The data are consistent with a ^{69}Ga-donor model, two levels of which are resolved by the TCFLS technique. The results illustrate the potentiality of TCFLS for determination of semiconductor forbidden-band state parameters, and also for carrier microscopic-mobility determination. Two model parameters, corresponding to the concentrations of the shallow forbidden-band states, were determined to within 3% standard error. (auth)

42167 OBSERVATION OF IRRADIATION-INDUCED INTERSTITIAL COPPER IMPURITY IN GERMANIUM. Hiraki, A.; Cleland, J. W.; Crawford, J. H. Jr. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. J. Appl. Phys., 38: 3519-22(Aug. 1967). (ORNL-P-2983).

The possibility that substitutional impurities can be displaced into interstitial sites in germanium by electron irradiation was investigated by electrical property measurements. The impurity chosen was copper since it is a triple acceptor in a lattice site, but is a donor when interstitial; hence, ejection of a single copper atom adds four electrons to the conduction band. Specimens of n-type germanium doped with both copper and antimony (the ratio of Cu to Sb was ~1:4) were irradiated with 1.6-MeV electrons at 77°K along with control specimens that contained no copper. The decrease in electron concentration n was appreciably less in the copper-doped specimen than in the control specimen, as would be anticipated if copper impurities were displaced into interstitial sites. Isochronal annealing at several temperatures between 77 and 260°K after irradiation produced a further decrease in n (reverse annealing) in the copper-doped specimens, whereas the control specimens showed a normal recovery of n. A likely explanation of the reverse annealing is that of restoration of irradiation-produced interstitial copper into substitutional sites through interaction with migrating vacancies. A type of negative photoconductivity was also observed in the temperature range in which reverse annealing occurred. (auth)

42168 IONIC CORROSION AS A FUNCTION OF THE ANGLE OF INCIDENCE OF THE IONS. Teodorescu, I. (Inst. of Physics, Bucharest). Rev. Roum. Phys., 12: 305-10(1967). (In French).

The manner in which the surface microscopic structure of some polycrystalline metallic samples (Al, Cu, Ag, Pd, Ni, Mo, Ta, and W) depends on the angle of incidence ϕ and the temperature T_p of the sample during ionic bombardment was studied. The study was made using hydrogen and nitrogen ions, which were replaced in some experiments by "air" or oxygen ions. The structures obtained were interpreted in the hypothesis of an initial microrelief and by taking into consideration the variation of the pulverization yield as a function of the angle of incidence. (tr-auth)

42169 NATURE OF THE CHANGE OF THE EFFECTIVE CONCENTRATION OF CURRENT CARRIERS IN A SERIES OF RARE EARTH DICARBIDES. Paderno, Yu. B.; Yupko, V. L. (Inst. of Materials Science Problems, Kiev). Izv. Akad. Nauk SSSR, Neorg. Mater., 3: 398-400(Feb. 1967). (In Russian).

An attempt was made to provide a qualitative explanation for variation in the experimental values of the effective concentration of carriers (n*) in a series of rare earth dicarbides from the standpoint of the probability of appearance of d states in the metal atoms and the energetic stability of the f energy states of rare earth atoms for given degrees of their filling. The qualitative dependence of the appearance of the 5-d state, n_{dM}, in the series of rare earth metals is given. This dependence is shown to be very similar to the nature of the change in the experimental values of n*. This similarity indirectly confirms an earlier hypothesis that the conduction in these rare earth dicarbides is accomplished mainly with 5d electrons. The change in n* and resistivity of the corresponding hexaborides is also discussed. (CFSTI)

42170 NUCLEAR-MAGNETIC-RESONANCE RELAXATION BY SPIN-ROTATIONAL INTERACTIONS IN THE SOLID. Blinc, R.; Lahajnar, G. (Univ. of Ljubljana, Yugoslavia). Phys. Rev. Lett., 19: 685-7(Sept. 18, 1967).

Experimental data are reported that show evidence that spin–rotational interactions operate in some molecular solids and represent in a certain temperature range the dominant NMR spin–lattice relaxation mechanism. The temperature dependences of the ^{19}F spin–lattice relaxation times of SF_6, SeF_6, and TeF_6 are presented and show, except at very low temperatures, the same anomalous behavior as found by Gutowsky and Hubbard to be characteristic for the presence of spin–rotational interactions. (J.H.M.)

42171 RADIATION EFFECTS ON SEMICONDUCTORS. Vavilov, V. S. (Lebedev Inst. of Physics, Moscow). Priroda, No. 2, 42-9(1966). (In Russian).

A brief review is given of the radiation effects on semiconductors. Simple radioinduced defects in semiconductors and

their reactions with impurities, concentration of defects, nuclear transmutation, and ionic alloying are discussed. (R.V.J.)

42172 ZIRCONIUM–NICKEL–SILICON SYSTEM. Voroshilov, Yu. V.; Markiv, V. Ya.; Gladyshevskii, E. I. (Lvov State Univ.). Izv. Akad. Nauk SSSR, Neorg. Mater., 3: 1404–8 (Aug. 1967). (In Russian).

X-ray structural analyses were made of the phase equilibria in the Zr–Ni–Si system at 800°C. Four new ternary compounds ($Zr_2Ni_2Si_3$, $ZrNi_2Si_2$, $Zr_4Ni_7Si_5$, and $Zr_{14}Ni_7Si_9$) were found and the existence of previously found compounds ($Zr_6Ni_{16}Si_7$ and ZrNiSi) was confirmed. The crystal structure of $ZrNi_2Si_2$ (of $CeGa_2Al_2$ type) showed a = 3.750, c = 9.680 Å, c/a = 2.58. (R.V.J.)

42173 ELASTICALLY SCATTERED RECOIL NUCLEI IN SOLID-STATE TRACK DETECTORS. Horn, P.; Von Oertzen, W. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Earth Planet. Sci. Lett., 2: 280-2(July 1967).

A method for calibration of the registration sensitivity for heavy ions in meteoritic and terrestrial minerals and glasses is described. (auth)

42174 ACTION OF NUCLEAR PARTICLES ON THE TRANSPORT PROPERTIES OF GALLIUM ARSENIDE MONOCRYSTALS OF THE N TYPE AND GALLIUM ANTIMONIDE MONOCRYSTALS OF THE P TYPE. Dubech, Gerard; Daspet, Danielle; de Lafond, Yann Gervais (Faculte des Sciences, Toulouse). Compt. Rend., Ser. A and B, 264: 1362–4(May 8, 1967). (In French).

Monocrystals of gallium arsenide and gallium antimonide were irradiated by 4-MeV electrons, fast reactor neutrons, and 3-BeV relativistic protons. The variations of the Hall coefficient and the resistivity were studied before and after irradiation between 80 and 390°K and during irradiation at constant temperature. The mobility of the conduction carriers undergoes different variations according to the temperature region considered. The effective rate of elimination of carriers was determined for proton, electron and neutron irradiation. The results are shown graphically. (J.S.R.)

42175 ELECTRONIC CONTROL OF FRITTED UO_2 TABLETS BEFORE AND AFTER IRRADIATION WITH NEUTRONS. Debiese, Jean; Klein, Siegfried; Gauthier, Andre; Lipskier, Marcel; Mathern, Fernand; Sorriaux, Andre (CEA, Gif-sur-Yvette, France). Compt. Rend., Ser. A and B, 264: 1563–4 (June 5, 1967). (In French).

Fritted uranium dioxide has the characteristics of a semiconductor. After neutron irradiation, its qualities are modified as a function of the appearance and migration of products of fission and transmutation. (tr-auth)

42176 222 ELECTRON REFLECTION FROM ALUMINIUM AND SYSTEMATIC INTERACTION. Nagata, Fumio; Fukuhara, Akira (Hitachi Central Research Lab., Tokyo). Jap. J. Appl. Phys., 6: 1233-5(Oct. 1967).

Energy dependence of electron diffraction from a bent-wedge crystal of Al was investigated experimentally at energies from 100 keV to 1 MeV as well as theoretically with particular interest in the systematic interaction. The (222) intensity at the crystal orientation for this reflection is remarkably reduced under observation at some 600 keV where two dispersion sheets cross each other; furthermore the measured energy dependence of a fine fringe appearing in the extinction contours agrees fairly well with the theoretical prediction. Around the orientation for (111) reflection the observed profile of (222) image intensity includes a fringe synchronous to that in the (111) intensity. As for (111) extinction distance, the present theoretical estimation gives a fringe period shorter by 9% and 16% at 100 keV and 1 MeV respectively than the simple two-ray approximation does. (auth)

42177 MEAN FREE PATH OF FAST ELECTRONS FOR PLASMON EXCITATION IN A SINGLE CRYSTAL. Tonomura, Akira; Watanabe, Hiroshi (Hitachi Ltd., Tokyo). Jap. J. Appl. Phys., 6: 1163-9(Oct. 1967).

The mean free path of 40 to 100-keV electrons for plasmon excitation was measured by analysing energy spectra of bright-field images of aluminum single crystals. Equal thickness fringes by (111) reflection were used to measure the specimen thickness. It was found that the mean free path slightly depends on the crystal orientation, and its voltage dependence at the exact Bragg condition agrees qualitatively with Ferrell's theory [Phys. Rev., 101: 554(1956)]. (auth)

42178 TRANSFER OF FINE STRUCTURE IN NUCLEAR MAGNETIC DOUBLE RESONANCE. Freeman, R.; Gestblom, Bo (Varian Associates, Palo Alto, Calif.). J. Chem. Phys., 47: 1472-9(Aug. 15, 1967).

In a nuclear magnetic double-resonance experiment, irradiation of one of the X resonances of an AX spin system with a second rf field $\gamma_X H_2/2\pi \ll |J_{AX}|$ splits each connected A line into a doublet; if there is any fine structure on the X resonance due to coupling to some third group of nuclei Z, and if $\gamma_X H_2/2\pi \gg |J_{XZ}|$, the same fine structure can be observed on the two components of the A doublets, except that the splitting is reduced by a factor of 2. Thus, under suitable conditions the double resonance process may be said to transfer fine structure splitting from the irradiated to the observed resonance. In cases where there is also fine structure present on the A resonance due to a small coupling J_{AZ}, the transferred splitting combines with it to give a new splitting $|J_{AZ} + \frac{1}{2}J_{XZ}|$ for progressively connected lines, or $|J_{AZ} - \frac{1}{2}J_{XZ}|$ for regressively connected lines. This technique has been used to detect a very small long-range coupling (+0.05 Hz) in 3-bromothiophene-2-aldehyde, where it is usually obscured by magnet field inhomogeneity. A second application is the indirect determination of the magnitude and sign of the coupling between carbon-13 and deuterium in methyl-d_3-acetylene, $J(^{13}C-C-D) = -1.5$ Hz. (auth)

42179 VARIATIONS OF THE CRYSTALLINE PARAMETERS OF ALUMINA IRRADIATED AT LOW TEMPERATURE DURING ANNEAL BETWEEN 90 AND 700°K. Pluchery, Max (CEN, Grenoble, France). Compt. Rend., Ser. A and B, 264: 1365–8 (May 8, 1967). (In French).

Alumina monocrystals were irradiated at 77°K at fast neutron doses from 1 to 7×10^{18} n.v.t. The evolution of the a and c parameters during the anneal, followed by means of a low-temperature x-ray diffractometer, shows a high number of stages. The expansion of the cell is equal to the macroscopic expansion deduced from density measurements. (tr-auth)

42180 ADSORPTION KINETICS OF NITROGEN ON RHENIUM. Scheer, Milton D.; McKinley, John D. (National Bureau of Standards, Washington, D. C.). Surface Sci., 5: 332-44(Nov. 1966).

The adsorption of room temperature nitrogen on atomically clean polycrystalline rhenium was studied. The sticking coefficients at zero coverage were found to be 0.060, 0.009, and 0.007 at rhenium surface temperatures of 205, 300, and 373°K respectively. These values are between one and two orders of magnitude smaller than those in the nitrogen–tungsten system. The dependence of the sticking coefficient upon surface coverage and temperature could be accounted for by assuming an intermediate state weakly bound to an adsorption site. These sites were assumed to be uniformly distributed over the surface. Their concentration was found to be less than $\frac{1}{10}$ of the number of substrate-rhenium atoms/cm². The binding energies of the intermediate state and the permanently adsorbed state were in the ratio of about 1:20 for both the nitrogen–rhenium and nitrogen–tungsten systems. In view of this similarity, it is difficult to account for the large difference in sticking probabilities unless one assumes that tungsten absorbs energy from the intermediate binding state much more efficiently than does the rhenium. (auth) (IAA)

42181 STUDY OF THE NIOBIUM(110) SURFACE USING LOW-ENERGY ELECTRON DIFFRACTION TECHNIQUES. Haas, T. W. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). Surface Sci., 5: 345-58(Nov. 1966).

A study of the cleaned Nb(110) surface was conducted. It was found that a clean surface can be produced in a properly oriented sample by heating to 2200°C for a short time. Data for intensity vs voltage for various beams show a great similarity to those obtained for the Mo(110) surface. Faceting due to heating or to argon ion bombardment was not found but probably does occur in the presence of oxygen. (auth) (IAA)

42182 ISOTOPE EFFECT IN THERMAL DIFFUSION IN SOLIDS. Barr, L. W. (Atomic Energy Research Establishment, Harwell, Eng.). Phil. Mag., 15: 1037-9(May 1967).

An equation is obtained relating the steady-state distribution of an isotopic tracer to the intrinsic heat of transport in a substance held in a temperature gradient. Systems to which the equation could be applied are discussed. (auth) (UK)

42183 QUANTUM MASS EFFECTS IN DIFFUSION. Ebisuzaki, Y.; Kass, W. J.; O'Keeffe, M. (Arizona State Univ., Tempe). Phil. Mag., 15: 1071-4(May 1967).

The temperature dependence of the ratio of isotope diffusion coefficients is discussed with particular reference to hydrogen in metals. (auth) (UK)

42184 FARADAY ROTATION OF F CENTRES IN ALKALINE EARTH FLUORIDES. Cavenett, B. C.; Hayes, W.; Hunter, I. C. (Oxford Univ.). Solid State Commun., 5: 653-6(Aug. 1967).

The optical absorption of F centers in additively colored alkaline earth fluorides is overlaid by absorption of comparable intensity due to F aggregate centers, and identification of the F band peaks by the usual methods is therefore difficult. In contrast with the F aggregate centers, however, F centers give rise to a temperature-dependent Faraday rotation pattern which enables the F

band peaks to be identified. Faraday rotation measurements are also reported on perturbed F centers produced by x irradiation at 77°K of hydrogen-doped crystals. (auth) (UK)

42185 NMR MEASUREMENT OF THE DIFFUSION COEFFICIENT OF PURE ALUMINUM. Fradin, F. Y.; Rowland, T. J. (Univ. of Illinois, Urbana). Appl. Phys. Lett., 11: 207-9 (Sept. 15, 1967).

Using a radio-frequency field pulse technique which enables measurement of slow atomic diffusion by means of nuclear magnetic resonance, for nominally 6–9's pure Al, an activation energy for self-diffusion of $28.7_5 \pm 0.8$ kcal/mole was obtained. Data were obtained over a range of 5 decades in atomic jump rate (240° to 550°C) and joins smoothly with other diffusion coefficient measurements at the extremes. (auth)

42186 CROSS SECTIONS OF FORMATIONS OF FRENKEL DEFECTS INDUCED BY ^{60}Co γ RAYS. Lebedev, A.T. (Ivanovsk Inst. of Power Engineering, USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 4, 58-61(1967). (In Russian).

The cross sections of Frenkel defects induced by ^{60}Co γ rays in solids with Z from 6 to 32 were calculated for three magnitudes with E_d = 15.25 and 35 eV. The obtained data were used for finding the empirical relation $\sigma = f(Z, E_d)$. (tr-auth)

42187 INDIVIDUAL INTERACTION BETWEEN AN INCIDENT ELECTRON AND A CONDUCTION ELECTRON DURING ELECTRON BOMBARDMENT OF A METAL. Cailler, M.; Offret, S. (Ecole Nationale Superieure de Mecanique, Nantes, France). J. Phys. (Paris), 28: 451-5(May-June 1967). (In French).

In order to determine the contribution of weakly bound electrons to the secondary electron emission yield induced by electron bombardment, the OPW method for calculating the transition probability of Bloch electrons to excited states leading to electron emission was applied. (auth)

42188 PHONON SCATTERING BY RADIATION-PRODUCED F-COMPLEMENT CENTERS. Sonder, E.; Walton, D. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Phys. Lett., 25A: 222-3(Aug. 14, 1967). (ORNL-P-3184).

From thermal conductivity measurements between 0.2 and 2°K on irradiated samples of KCl it is inferred that large clusters of Cl atoms are formed, the sizes of which depend upon the radiation temperature. (auth)

42189 PARAMAGNETIC CENTRES IN PROTON-IRRADIATED SILICON. Luetgemeier, H.; Schnitzke, K. Phys. Lett., 25A: 232-3(Aug. 14, 1967).

As in the case of neutron irradiation, P1, P3, and P6 centers occur in silicon after irradiation with protons of 3 MeV. A new $S = \frac{1}{2}$ center is observed which is axially symmetric along the [111] axis and has the eigenvalues $g_{||} = 2.0010$ and $g_{\perp} = 2.0103$. (auth)

42190 ELECTRON IRRADIATION OF PURE AND ALLOYED ALUMINUM ABOVE STAGE I. Peters, P. B.; Shearin, P. E. (Univ. of North Carolina, Chapel Hill). Phys. Lett., 25A: 267-8 (Aug. 14, 1967).

Electron irradiation at 2 MeV of pure (99.9999%) and dilutely alloyed aluminum has been performed near 65°K and the increase of electrical resistivity with electron flux measured. The resulting production curves are interpreted. (auth)

42191 MEASUREMENTS OF THE POLARIZATION OF FIELD EMITTED ELECTRONS FROM POLYCRYSTALLINE GADOLINIUM. Hofmann, M. (Univ., Munich); Regenfus, G.; Schaerpf, O.; Kennedy, P. J. Phys. Lett., 25A: 270-1(Aug. 14, 1967).

Below the Curie temperature the field-emission electrons from magnetized Gd show spin polarization—at 85°K ~ 8% ± 1.5%. (auth)

42192 ELECTRON-PARAMAGNETIC-RESONANCE STUDIES OF THE FLUORINE DONOR IN BERYLLIUM OXIDE. Reinberg, A. R.; Estle, T. L. (Texas Instruments Inc., Dallas). Contract AF49(638)-1250. Phys. Rev., 160: 263-73(Aug. 10, 1967).

A prominent point imperfection observed by electron paramagnetic resonance in x-irradiated single-crystal BeO containing fluorine has been studied under varying conditions of temperature and uniaxial stress. This point imperfection in its neutral, paramagnetic charge state consists of one electron in excess of saturated bonds and closed shells, trapped near the fluorine impurity. The fluorine impurity substitutes for oxygen in the BeO lattice and, isolated from other defects, is a deep donor. The extra electron occupies an orbital localized primarily on two of the three basal beryllium ions nearest the fluorine. The observed temperature dependence of the ^{9}Be hyperfine structure is analyzed by using a classical model of random hopping among the three two-beryllium states of the donor. The resulting slight dependence of the hopping rate on temperature is discussed in terms of a quantum-statistical picture. The three states are coupled through nonzero matrix elements of the vibrational energy but are partially decoupled as a result of large static random strains in the crystals. (auth)

42193 PHOTON EMISSION FROM Al FOILS BOMBARDED BY NON-NORMALLY INCIDENT ELECTRONS. Ashley, J. C.; Cram, L. S.; Arakawa, E. T. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Phys. Rev., 160: 313-15(Aug. 10, 1967). (ORNL-P-2617).

The intense photon emission from Ag bombarded by grazing-incidence electrons has been ascribed by Boersch et al., to the decay of surface plasmons. In order to check the validity of this assumption, photon emission from vacuum-evaporated Al foils 260 Å in thickness bombarded by 80-keV electrons was investigated as a function of angle of electron incidence (ξ). A peak was found in the emission spectrum at λ = 760 Å using normal-incidence electrons, in accord with earlier investigations. This peak decreased in intensity as ξ increased, until a minimum was reached at ξ = 60°. Another peak in the spectrum around λ = 800 Å was then seen to arise for larger angles of incidence, whose intensity increased as ξ increased from 70° to 85°. No peak was detected in the wavelength region 1200 to 1500 Å, the region corresponding to the surface plasma energy of Al. These experimental observations can be explained fully in terms of transition radiation and bremsstrahlung. (auth)

42194 PARAMAGNETIC CENTERS IN GAMMA-RAY-IRRADIATED SODIUM BROMATE. Gamble, F. T. (Denison Univ., Granville, Ohio. Battelle Memorial Inst., Columbus, Ohio). J. Chem. Phys., 47: 1193-4(Aug. 1, 1967).

Single crystals of sodium bromate were gamma irradiated at room temperature in tubular ^{60}Co sources. Electron spin resonance (ESR) studies of the irradiated crystals were made with a conventional X-band spectrometer at room temperature and at 77°K. Studies of the change in line shape for rotations of the crystals about the [100], [110], and [111] axes relative to the external magnetic field showed the presence of spin-½ centers whose spectra were superimposed upon a broader asymmetric resonance. The absorption intensity of the resonance line associated with the spin-½ centers increased to a maximum with a dose of 6 to 7×10^7 R and thereafter decreased. The spin-½ resonance line annealed more rapidly than the background resonance and to eventual extinction. It is tentatively suggested that the spin-½ centers are holes trapped at either sodium or bromine vacancies. (A.G.W.)

42195 EFFECTIVE FIELD PARAMETERS IN IRON MOESSBAUER SPECTROSCOPY. Hoy, Gilbert R.; Chandra, Subhas (Boston Univ.). J. Chem. Phys., 47: 961-5(Aug. 1, 1967).

Relatively simple computational methods for interpreting Mössbauer spectra, in which there are simultaneously static quadrupole and hyperfine interactions, have been developed. The explicit calculations are restricted to the case when either the source or absorber is a "single line" and the nuclear levels are the same as in the ^{57}Fe 14.4-keV transition. Experimental spectra for powdered $RbFeF_3$ and $FeCr_2S_4$ have been obtained and are analyzed using these methods. The results show that although the quadrupole interaction ΔE_Q is zero above the transition temperatures of both $RbFeF_3$ and $Fe\,Cr_2S_4$ it is rather large below, i.e., in $FeCr_2S_4$, ΔE_Q = 0.78 mm/sec at 77°K and in $RbFeF_3$, ΔE_Q = 3.00 mm/sec at 4°K. The isomer shift, the effective internal magnetic field, and its orientation with respect to the principal axes of the electric-field-gradient tensor in these substances at various temperatures are also obtained. (auth)

42196 ELEKTRONNYE I IONNYE PROTSESSY V TVERDYKH TELAKH. II. (Electron and Ion Processes in Solids. Volume II). Tbilisi, USSR, Izdatel'stvo Metsniereba, 1965. 103p.

Separate abstracts were prepared for the 8 included papers. (M.O.W.)

For abstracts of individual papers see: 42197 and 42198–42204.

42197 RADIATION EFFECTS ON DISLOCATION DENSITY IN ALKALI METAL HALIDE CRYSTALS IRRADIATED IN A REACTOR AT NORMAL AND LOW TEMPERATURES. Andronikashvili, E. L.; Politov, N. G.; Getiya, M. Sh.; Galustashvili, M. V. pp 3-13 of Elektronnye i Ionnye Protsessy v Tverdykh Telakh. Vol. II. Tbilisi, USSR, Izdatel'stvo Metsniereba, 1965. (In Russian).

Samples were irradiated in the Institute of Reactor Technology at 155 and 110°K at the Institute of Physics, AN GruzSSR. The dependence of dislocation density on irradiation time and temperature was studied. Dislocation density was determined in two ways: (1) the number of dislocations were counted in random portions of a series of irradiated samples with the aid of a standard, and (2) the relative variation in dislocation density on irradiated surfaces was determined by comparison with a control

surface of one sample (mirror crystal method). The latter method is more accurate. Curves are plotted for the number of dislocations in LiF crystals as dependent on irradiation time in the vertical experimental reactor channel (nv = 1.1×10^{12} neutrons/cm^2 sec, 85-mm-thick lead target attenuating the gamma radiation), in the vertical low temperature loop (nv = 5.5×10^{11} neutrons/cm^2 sec), and in the horizontal low temperature loop (nv = 1.8×10^{12} neutrons/cm^2 sec). More radiation-generated dislocations and fewer vacancies occurred in samples exposed to the attenuated gamma radiation. The dislocations in these crystals apparently form from the condensation of point defects. The ratio D/D_0 was measured after sample irradiation in a beam of 1.8×10^{12} neutrons/cm^2 sec at 100°K in a range of energies from 3×10^{14} to 10^{15} nvt. The ratio increases with increase in irradiation time, and the dislocation density at 110°K is about 20% less than at 300°K. Results at 155°K coincide with those at 300°K. The effect of annealing on dislocation density is described. The dependence of dislocation density in LiF crystals on the temperature during irradiation confirms the condensation theory of dislocation generation. Selective etching of the test samples revealed the nature and distribution of point defects. Microphotographs of crystals etched after irradiation show extensive pitting, which increases with higher dosages. Effects of irradiation and subsequent annealing on the density and nature of pitting and the mechanical properties of the crystals are described. From the experimental data it is concluded that irradiation causes point defects to merge. These defects have greater dynamic resistance to the motion of dislocations than do individual vacancies, interstitial atoms, and individual impurity atoms. Annealing causes the point defects to unite into plane cavities. The annealing time and temperature and the rate of cooling all affect the mechanical properties of the irradiated crystals. (ATD)

42198 FORMATION OF COLOR CENTERS IN ALKALI HALIDE CRYSTALS IRRADIATED IN A REACTOR AT USUAL AND LOW TEMPERATURES. Andronikashvili, E. L.; Politov, N. G.; Abramishvili, M. G. pp 14-18 of Elektronnye i Ionnye Protsessy v Tverdykh Telakh. Vol. II. Tbilisi, USSR, Izdatel'stvo Metsniereba, 1965. (In Russian).

An investigation was made of the coloring of lithium fluoride and potassium chloride crystals irradiated in the vertical experimental channel of a reactor at room temperature (300°K) and in low-temperature at 300, 155, and 110°K. The IRT reactor at the Physics Institute of the Academy of Sciences of the Georgian SSR was used for the low-temperature measurements. The measurements of optical absorption by LiF crystals irradiated in a reactor channel with nv = 3.2×10^{12} neutron/cm^2 sec showed that with an increase in irradiation time the coloring increased nonmonotonically: the maxima were replaced by minima. Apparently, both neutrons and gamma-quanta contribute to the coloring. The comparison of results showed that in a channel with a weaker intensity of neutron flux and with a gamma screen the specimens were colored more weakly. Irradiation in a channel with a gamma screen caused a more intensive generation of dislocations. The attenuation of the gamma radiation also caused a decrease in the coloring of KCl crystals. A decrease in the irradiation temperature resulted in considerably weaker coloring of the LiF crystals. For KCl crystals, the coloring was stronger when the irradiation temperature was lowered. (ATD)

42199 EPR AND OPTICAL ABSORPTION IN NEUTRON-IRRADIATED LITHIUM FLUORIDE CRYSTALS. Dzhordzhishvili, L. I.; Kalabegishvili, T. L.; Politov, N. G.; Sobolevskaya, S. V. pp 19-26 of Elektronnye i Ionnye Protsessy v Tverdykh Telakh. Vol. II. Tbilisi, USSR, Izdatel'stvo Metsniereba, 1965. (In Russian).

Test samples of LiF were cut from monocrystalline melts of natural material and irradiated in the atomic reactor of the Physics Institute, AN GruzSSR. The radiation energy of 1.9×10^{15} to 2.9×10^{16} was selected because alkali halide crystals are known to change their optical and mechanical characteristics significantly at these energies. EPR spectra were studied with standard radiospectrometers and with a doubly modulated magnetic field. The field was calibrated from the proton resonance signal and measurements were made at 77 and 290°K. The EPR spectrum approximates a Gaussian curve, and the width of the EPR absorption line depends on crystal orientation to the magnetic field as well as on the radiation dosage. The coloration curve of the LiF crystals is the reverse of the dosage-dislocation density curve. The correlation between the dosage and the width of the EPR absorption spectrum is due partly to the broad F-center line and partly to a narrow line which appears at resonance saturation and has a g factor close to that of the F center. The effects of these two lines are different at different dosage levels. The narrow line is attributed to concentrations of closely packed and strongly interacting F centers near dislocations. It is suggested that two types of F centers are formed by the irradiation: (1) isotropically distributed centers in the bulk of the crystal, and (2) centers arising as highly localized concentrations near dislocations. With high dosages there is no F-center signal (up to 1.3×10^{19} n/cm^2), and a signal arises from conduction electrons because the F centers coagulate and colloidal metal forms in the lattice. At maximum dosage the lattice fragments and the metallic lithium oxidizes. (ATD)

42200 RADIATION EFFECTS ON THE CONDUCTIVITY OF KCl AND LiF CRYSTALS. Andronikashvili, E. L.; Vorozheikina, L. F.; Igitkhanishvili, D. D.; Politov, N. G. pp 27-34 of Elektronnye i Ionnye Protsessy v Tverdykh Telakh. Vol. II. Tbilisi, USSR, Izdatel'stvo Metsniereba, 1965. (In Russian).

An investigation was made of the relationship between the ionic conductivity and the activation energy of carriers in KCl and LiF crystals caused by reactor irradiation. The temperature dependence of ionic conductivity was investigated in the range from 50 to 400°C. The heating of the specimens was carried out at a constant rate of 1°C/min. The measurements were made in a vacuum of 10^{-4} mm Hg. The specimens were irradiated in the IRT reactor of the Physics Institute of the Academy of Sciences, Georgian SSR at a point where the thermal neutron flux was 2.07×10^{12} neutrons/cm^2 · sec. The conductivity was measured before and after irradiation with specimens produced from a single ingot. Radiative changes in conductivity accompanied sharp changes in the crystal microstructure following irradiation with "critical" doses. For example, KCl crystals irradiated with a dose of 1.2×10^{16} n/cm^2 displayed a minimum of dislocations when the activation energy was at a minimum and the conductivity was at a maximum. KCl specimens irradiated with doses of 5.8×10^{16} n/cm^2 and 1.1×10^{17} n/cm^2 had activation energies of the current carriers of 0.96 eV and 0.84 eV, respectively. Prior to irradiation, the activation energies were 0.84 eV and 1.0 eV, respectively. The thermal treatment taking place during the measurement of conductivity in KCl specimens irradiated at 7.6×10^{15} n/cm^2 in the temperature range from 75 to 300°C did not produce any changes in the conductivity or the activation energy of the current carriers. In LiF crystals, each thermal treatment increased the conductivity of the specimen and decreased its activation energy. (ATD)

42201 LOW FREQUENCY INTERNAL FRICTION IN LITHIUM FLUORIDE CRYSTALS. Politov, N. G.; Driyaev, D. G. pp 35-9 of Elektronnye i Ionnye Protsessy v Tverdykh Telakh. Vol. II. Tbilisi, USSR, Izdatel'stvo Metsniereba, 1965. (In Russian).

Results are given of a study of the effect of x irradiation and mechanical deformation on the internal friction in LiF crystals at infralow frequencies. Measurements were made with a torsion pendulum relaxation instrument. This required LiF samples 2 × 2 × 60 mm. The temperature dependence of the internal friction coefficient, Q^{-1} was measured over the range from the temperature of liquid nitrogen to room temperature. Samples were annealed at 700°C for 5 hr, were cooled to liquid nitrogen temperature, and then were warmed at the rate of 0.5 deg/min to room temperature, Q^{-1} being measured at intervals of 3°K. Curves were plotted for a sample before and after x-ray exposure at 30 kV, 10 mA, for ~1 hr at room temperature. Before irradiation the Q^{-1} curve shows several more-or-less low peaks between 100 and 300°K, notably at 160°K (peak 1) and 210°K (peak 2). After irradiation, peak 1 vanished, whereas peak 2 grew sharply. The tests were repeated after 3 days, during which the crystals were maintained at room temperature. Peak 1 reappeared and peak 2 decreased somewhat. Upon reexposure to x rays, peak 1 decreased, but not as much as the first time. The crystals were subjected to 1% deformation, which was found to have an effect opposite to that of x irradiation: peak 1 grew, whereas peak 2 fell. After 3 days at room temperature, the peaks returned to their initial state. The rise and fall of the peaks is explained as due to the Schulman–Compton mechanism, in which vacancies are generated by the irradiation, coupled with Varley's multiple ionization and Seitz's dislocation mechanisms. The excitons formed by the x rays decay and the halogen ion localized at the line of dislocation ionizes. The resulting atom departs, leaving a vacancy. The decay of another neighboring exciton causes one of the halogen ions of the normal lattice to fill the vacancy, leaving a free halogen vacancy. This mechanism results in a drift of the dislocations. The effect of deformation on the behavior of the peaks is explained. Peak 1 is associated with "dislocation" type internal friction; peak 2 with "vacancy" type internal friction. (ATD)

42202 THERMOLUMINESCENCE AND OPTICAL ABSORPTION SPECTRA OF IRRADIATED LiF CRYSTALS. Davitashvili, T. Sh.; Zhvaniya, M. F. pp 40-5 of Elektronnye i Ionnye Protsessy v Tverdykh Telakh. Vol. II. Tbilisi, USSR, Izdatel'stvo Metsniereba, 1965. (In Russian).

An investigation was made of the generation of dislocations in alkali halide crystals irradiated in an atomic reactor. Specimens 10 × 0.8 × 0.5 cm taken from a single crystalline ingot were annealed at 700°K (one week), cooled slowly (two days) to room temperature, split into smaller 1.5 × 0.8 × 0.5 m specimens, and separated into three groups. The first group was irradiated in the active zone of a nuclear reactor at a normal temperature (310°K, with a thermal neutron intensity of 1.1×10^{12} n/cm²·sec), the second was irradiated at low temperature (155°K, with a thermal neutron intensity of 0.55×10^{12} n/cm²·sec), and the third was irradiated in a radiative gamma loop at room temperature (dose rate 8×10^5 r/hr). With an increase in neutron flux or in gamma-ray dose, the intensity of the low-temperature peaks decreased, dropping to zero, and a new peak (or peaks) formed in the higher-temperature region. A displacement of peaks to the high-temperature side and a suppression of low-temperature peaks occurred. These changes were less noticeable in LiF crystals irradiated in the gamma-loop, and were not observed at all in KCl crystals irradiated in the reactor. It is concluded that the changes are the result of a specific neutron effect on LiF crystals: the amplification of the generation of radiative damages of the crystal lattice caused by the products resulting from nuclear reaction on the ^{6}Li isotope (high-energy alpha particles appearing in the crystal lattice itself) as the result of the capture of thermal neutrons. (ATD)

42203 NEUTRON SCATTERING ON CONDUCTION ELECTRONS IN A QUANTIZING MAGNETIC FIELD. Kharadze, G. A. pp 82-8 of Elektronnye i Ionnye Protsessy v Tverdykh Telakh. Vol. II. Tbilisi, USSR, Izdatel'stvo Metsniereba, 1965. (In Russian).

An attempt is made to define the conditions for direct observation of the effects of spatial quantization of electron states in experiments involving magnetic scattering of neutrons. Starting with the operator describing the interaction between the magnetic moment of the neutron and the magnetic field of a system of conduction electrons and the state of the latter expressed in terms of a set of quantum numbers, a mathematical treatment of the problem is developed. (ATD)

42204 SCATTERING OF SLOW NEUTRONS ON DOMAIN WALLS IN FERROMAGNETIC MATERIALS. Ratishvili, I. G. pp 89-95 of Elektronnye i Ionnye Protsessy v Tverdykh Telakh. Vol. II. Tbilisi, USSR, Izdatel'stvo Metsniereba, 1965. (In Russian).

Ferromagnetic regions in a monocrystal are separated by boundaries, domain walls, consisting of tens to hundreds of atomic planes which rotate the magnetic vector. These walls produce many effects, including the scattering of slow neutrons. A mathematical description of elastic scattering, first for any magnetic structure and then for a magnetic rotation of 180° from a single crystal is given. It is shown that the scattering depends on the orientation of the scattering plane with respect to the plane of the domain wall, and the orientation of the latter can thus be determined. A coordinate system is selected such that x is along the magnetization of the domain and z is normal to the wall, and y completes the rectangular system. The scattering from the various crystal planes is given: (1) Plane x0z produces a reflection at the Bragg angle $2\phi_0$. The same neutron beam will reflect from the domain wall at the angle $2\phi_0 + \Delta\phi_1$. For an iron single crystal there are about 300 atomic planes perpendicular to the z axis and $\Delta\phi_1$ is approximately 10′ and is independent of the incident neutron energy. (2) Scattering with respect to intensity from the x0y plane is the same as in case 1, but the wall maximum depends on the Bragg angle. For an iron single crystal $\Delta\phi_2 \approx 2'$, for a neutron energy of 0.025 eV and ≈15′ for 0.003 eV. (3) From the y0z plane there is no domain maximum and the scattering from the wall is the same as from the x0z plane. Reflection from a polycrystal is examined briefly, and comparisons are made. Inelastic scattering is related to excitations of a given magnetic system and is different from the domain and from the domain wall to the degree their magnetic systems differ. The most interesting effect is the narrowing of the gap in the excitation spectrum of the spins, which characterize the domain wall, as compared with ordinary spin waves. (ATD)

42205 VZAIMODEISTVIE IZLUCHENIYA S VESHCHESTVOM. (Radiation Interactions with Solids). Alekseev, A. I. (ed.). Moscow, Atomizdat, 1966. 176p.

Twelve articles are included on radiation interactions with solids. Collective excitation in a nonideal Fermi gas, photon density relaxation, and photon spectra in resonance media are discussed. Angular distribution of bremsstrahlung in the target and fast charged particles moving in external electromagnetic field are evaluated. Three abstracts have been prepared for articles of special interest. (R.V.J.)

For abstracts of individual papers see: 41758, 42206, and 42207.

42206 ANGULAR DISTRIBUTION OF BREMSSTRAHLUNG RADIATION IN A TARGET TAKING INTO ACCOUNT THE LANDAU–POMERANCHUK EFFECT. Kalashnikov, N. P.; Ryazanov, M. I. pp 148-61 of Vzaimodeistvie Izlucheniya s Veshchestvom. Alekseev, A. I. (ed.). Moscow, Atomizdat, 1966. (In Russian).

The influence of multiple scattering on the angular distributions of bremsstrahlung of ultrarelativistic electrons in a medium was investigated. Multiple scattering of an incident electron and multiple scattering in the effective region alter considerably the angular distribution and energy spectra of the bremsstrahlung in the target. Calculations were made without considering kinetic equations and matrix density. The bremsstrahlung energy spectra integrated according to the photon emission were in agreement with the results obtained by L. D. Landau, E. M. Lifshits, and A. B. Migdal. (tr-auth)

42207 QUANTIZATION OF ELECTROMAGNETIC FIELD IN MAGNETOACTIVE MEDIA. Karavaev, E. I. pp 167-76 of Vzaimodeistvie Izlucheniya s Veshchestvom. Alekseev, A. I. (ed.). Moscow, Atomizdat, 1966. (In Russian).

An electromagnetic field in a magnetoactive medium is quantized and it is shown that the probability of atomic emission in a magnetic uniaxial crystal formally coincided with the probability of emission in a nonmagnetic uniaxial crystal. (tr-auth)

42208 MOESSBAUER EFFECT STUDY OF THE CRYSTAL FIELD POTENTIAL IN INTERMETALLIC COMPOUNDS OF THULIUM. Genin, Dennis Joseph. Ames, Iowa, Iowa State Univ. of Science and Tech., 1966. 117p. (IS-T-104).

Thesis.

Crystal field potentials in Tm intermetallic compounds were investigated by measuring the temperature dependence of the nuclear quadrupole splitting of the 8.42-keV γ transition in ^{169}Tm. Mössbauer effect investigations were carried out in the temperature range between 4.2 and 300°K. The quadrupole splittings were accurately determined by computer-fitting theoretical lineshapes to the data. Crystal field parameters for the C_{3v} symmetry in $TmRu_2$ and $TmMn_2$ were determined by a best fit to the temperature dependence of the quadrupole interaction. Overall crystal field splittings were found to be 92 cm^{-1} and 69 cm^{-1} in $TmRu_2$ and $TmMn_2$, respectively. Crystal field potentials can be studied in this investigation because the dominant quadrupole interaction at low temperatures is between the nuclear quadrupole moment and the electric field gradient produced by the polarization of the 4f electrons by the crystal field. In both compounds the conduction electron contribution to the electric field gradient was found to be opposite in sign to the temperature-independent lattice contribution. Large shielding of the 4f-electrons from the crystal field, expressed by the shielding factor σ_2, was noted. Anomalous line broadening at low temperatures was explained on the basis of a range of crystal field potentials at the Tm^{3+} ion sites due to lattice imperfections. (auth)

42209 RELATIVISTIC ENERGY BANDS AND FERMI SURFACES FOR SOME HEAVY ELEMENTS. Keeton, Stewart Charles. Ames, Iowa, Iowa State Univ. of Science and Tech., 1966. 123p. (IS-T-109).

Thesis.

A theoretical investigation of the relativistic effects on the band structure of heavy metals, i.e., metals composed of heavy elements, is reported. The theoretical method used in the calculations presented here was the relativistic augmented-plane-wave method. Relativistic and nonrelativistic energy bands are compared for Lu, Ac, and Th. The relativistic effects are particularly striking for Ac and Th. One relativistic effect that is quite apparent from the energy bands presented here is the tighter binding of the atomic electrons with low angular momentum. This has the effect of moving the s-like band in Ac and Th down by about 0.2 Rydberg at the center of the Brillouin zone. The energy bands and Fermi surfaces of Hg, Th, and Dy are also presented. Available experimental de Haas–van Alphen and magnetoresistance data are compared with theoretical predictions calculated for Hg. The agreement is good. The experimental density of states at the Fermi level obtained from specific heat and magnetic susceptibility measurements for Th are compared with the calculated value for Th found in this investigation. The agreement implies that electron–phonon and electron–electron interactions may be unimportant for Th. Theoretical predictions are also presented for de Haas–van Alphen frequencies and cyclotron effective masses for Th. The calculated Fermi surface for Dy implies that the shape of this surface is such as to favor an antiferromagnetic superlattice. The predicted periodicity of this antiferromagnetic structure agrees with the values obtained from neutron-diffraction experiments. (Disser. Abstr.)

Theoretical Physics

Refer also to abstracts 42444 and 42445.

42210 FEASIBILITY OF GENERATING AND RECEIVING COHERENT GRAVITATIONAL WAVES BY OPTICALLY CLOSED SYSTEMS. Nagibarov, V. R.; Kopvillem, U. Kh. (Physical-Technical Inst., Kazan). JETP Lett. (USSR) (Engl. Transl.), 5: 360-2(June 15, 1967).

Translated from Zh. Ekp. Teor. Fiz., Pis'ma Redaktsiyu, 5: 445-8(June 15, 1967).

The possibility of creating a superradiating gravitational state of quantum systems that are in a super-nonradiating electromagnetic state is discussed. The latter term denotes that the quantum emits photons at a power lower than the power of spontaneous emission of an isolated particle under certain conditions. (M.H.R.)

42211 SCATTERING OF TWO PLANE ELECTROMAGNETIC WAVES IN NONLINEAR BORN–INFELD ELECTRODYNAMICS. Barbashov, B. M.; Chernikov, N. A. (Joint Inst. for Nuclear Research, Dubna). Commun. Math. Phys., 3: 313-22(1966).

An identity was previously established between the equation describing the nonlinear scaler field in the two-dimensional pseudo-Euclidean space x,t with the Born–Infeld Lagrangian. On the basis of the analogy between this equation and the minimal surfaces a generalization of the Lagrangian was suggested for the situation of many nonlinear fields interacting in a definite way in the two-dimensional space. This system gives the exact solution. To provide this generalization the problem is considered of the minimal two-dimensional surface in a n + two-dimensional space. It was found that the shape and direction of the plane waves after scattering are unchanged. There is only a change in the wave phase by the value which is the product of its frequency and the momentum of the incident wave. It is shown that in the interaction region the solution becomes a multiple-valued function of x,t when the electromagnetic field exceeds a certain value which plays the role of an absolute field scale. (BBB)

42212 THE STATIC SOLUTION WITH SPHERICAL SYMMETRY OF THE JORDAN–THIRY FIELD EQUATIONS. Dangvu, Huyen (Paris Univ.). Compt. Rend., Ser. A and B, 264: 981-4 (May 29, 1967). (In French).

The notations on the results obtained in a preceding study of the static solutions with spherical symmetry of the Jordan–Thiry field equations are expanded to the case where the central mass is zero and to the case where the central mass is charged. (J.S.R.)

42213 KOENIG THEOREM AND RELATIVITY. Chylinski, Z. (Inst. of Nuclear Research, Krakow). Acta Phys. Pol., 32: 3-20(July 1967).

A generalization of the nonrelativistic Koenig theorem for finite velocity of light is proposed. It provides a new parametrization of the internal degrees of freedom of any isolated system and leads to the correspondingly generalized Schroedinger equation of its internal motion. Although this equation is not covariant under the Lorentz transformations, it determines the Lorentz-invariant amplitudes, as well as the Lorentz-invariant masses of the composite systems. Within the proposed framework one obtains an enlarged class of dynamical models. In the nonrelativistic limit this dynamics corresponds to the interaction described by the potentials, while in the case of finite c it is equivalent to the phenomenological S-matrix theory dealing with form factors parametrized in terms of the momentum invariants. (auth)

42214 LANCZOS IDENTITY AND ITS GENERALIZATIONS. Lovelock, David. Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur., 42: 187-94(Feb. 1967).

Identities between certain tensors involving an integral parameter are established. It is shown that by imposing restrictions on the dimensionality of the space generalizations are obtainable. The evenness and oddness of dimensionality appear to play an unexpectedly important role. (W.D.M.)

42215 ON THE SPECTRAL FUNCTIONS OF THE TWO-PARTICLE GREEN'S FUNCTION IN NONRELATIVISTIC MANY-FERMION PROBLEMS. Rohozinski, S. G. (Univ. of Warsaw). Acta Phys. Pol., 32: 61-75(July 1967).

The spectral representation of the two-particle Green's function in a nonrelativistic many-fermion problem is obtained. The spectral functions are expressed by boundary values of the analytic continuation of the Green's function. Some remarks on the spectral representation of the vertex part of the two-particle Green's function are made. (auth)

42216 THEORY OF SPHERICALLY SYMMETRIC SPACE–TIMES. Takeno, Hyoitiro. Sci. Rep. Res. Inst. Theoret. Phys., Hiroshima Univ., No. 5, 1-303(1966).

The discussion of spherically symmetric space times includes such topics as spherical symmetry, invariant classification, the characteristic system defined from the standpoint of the theory of invariants, and discrimination of spherically symmetric space–times. The groups of motions and those of conformal transformations in spherically symmetric space–times are determined completely, and from the standpoint of these groups the space–times are classified invariantly in terms of their characteristic systems. The problem of imbedding a spherically symmetric space–time in a flat space of higher dimension and that of conformal correspondence of spherically symmetric space–times are discussed respectively. The general forms of form-invariant geometric quantities under each group of motions and those of parallel tensors are respectively determined. Spherically symmetric space–times with corresponding geodesics are considered, and a method of generalizing the results thus obtained into an $n(\geq 5)$-dimensional case is given. (J.F.P.)

42217 CONTRIBUTION TO A MINKOWSKI FORMULATION OF EINSTEIN GRAVITATION BY A ROSEN-TYPE METHOD. Dangvu, Huyen (Institut Henri Poincare, Paris). Cah. Phys., 21: 53-100(Feb. 1967). (In French).

It has been shown that the Einstein gravitation theory can be considered as a gravitation theory in an absolute Minkowski space–time. This theory is formulated in the space–time of special relativity independently of the formalism of general relativity. It is shown that within the framework of special relativity the equivalence principle admits the corollary that the trajectory of a point test particle in a gravitation field are geodesics of a configuration variety V_4 provided with a normal hyperbolic type metric. A system formed of any relativistic field and of its test particle is considered and an attempt is made, outside the Lorentz invariants, to determine for which special transformation T the movement equations and the field equations are invariant. In order to establish the relation between the gravitational potential and the metric tensors of the Einstein variety and of the Minkowski space–time the Rosen formalism is used. A Minkowski theory of Einstein gravitation is constructed analogous to the Maxwell theory. The conservation laws of the theory are established. The unitary theory of Jordan and Thiry are then studied. Their formalism is briefly reviewed. It is established that the gauge transformations of the gravitational field as those of the electromagnetic field are adapted coordinated transformations and of the Jordan and Thiry variety and that one can define the mass and the charge of the test particle. These definitions are shown to be compatible with the expressions of the densities of mass and charge given by the field equations. The expressions of the Einstein tensor and of the field equation in adapted natural coordinates are calculated. The field calculations are then calculated in the first approximation and it is shown that, in this approximation, the expression of the action integral obtained is acceptable if the theory is considered as a unitary theory of three fields but that it is unacceptable if the theory is considered as a unitary theory of two fields only. (J.S.R.)

42218 INTRINSIC PROBLEMS IN EVOLUTION OF THE EINSTEIN EQUATIONS. Caricato, Gaetano. Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur., 42: 46-52(Jan. 1967). (In Italian).

An integration method established by Bruhat is adapted to the reduced problem of evolution for the vacuum Einstein's equations. The applicability of the method needs three suitable supplementary conditions on Cauchy's data. (auth)

42219 A NOTE ON L. D. FADDEEV'S THREE-PARTICLE THEORY. Albeverio, S.; Hunziker, W.; Schneider, W.; Schrader, R. (Eidgenossische Technische Hochschule, Zurich). Helv. Phys. Acta, 40: 745-8(Oct. 1, 1967).

An error in L. D. Faddeev's work on quantum mechanical three-particle systems is pointed out and corrected. (auth)

42220 CONFORMAL FLAT GRAVITATIONAL FIELDS. Stephani, H. (Univ., Jena, Ger.). Commun. Math. Phys., 5: 337-42(1967). (In German).

Using properties of an embedding in a flat six-dimensional space, all solutions of the Einstein equations for a perfect fluid or an electromagnetic field are given, which are conformal to a flat space. (auth)

42221 GRAVITATIONAL RADIATION. Zund, Joseph; Levine, Jack (North Caroline State Univ., Raleigh). Compt. Rend., Ser. A and B, 264: 1029-32(June 5, 1967). (In French).

A class of exact solutions representing a pure total radiation state in the sense of A. Lichnerowicz is reported. Some properties of this solution are investigated and a class of singular electromagnetic fields is constructed. (tr-auth)

42222 NUMERICAL SOLUTION OF THE ONE-DIMENSIONAL SCHROEDINGER EQUATION FOR BRANCHED π-ELECTRON

SYSTEMS WITH A DIGITAL COMPUTER. Stratmann, W.; Seelig, F. F. (Univ., Marburg, Ger.). Z. Naturforsch., 22a: 998–1005 (July 1967). (In German).

In the one-dimensional electron gas model the solutions of a one-dimensional Schrödinger equation are needed. For this purpose the usual Hamiltonian is substituted by its finite-difference approximation. This yields a set of formulas which enable to find the solutions of the Schrödinger equation by an iterative method. Special provisions are made for the one-dimensional coordinate, which may have a branched form. A program in FORTRAN II for the calculation of the absorption maxima of organic dyes is shortly described. (auth)

42223 RELATIVISTIC THERMODYNAMICS: A STRANGE INCIDENT IN THE HISTORY OF PHYSICS. Moeller, C. Kgl. Dan. Vidensk. Selsk., Mat.-Fys. Medd., 36: No. 1, 1-27(1967).

In view of the confusion which has arisen in the later years regarding the correct formulation of relativistic thermodynamics, the case of arbitrary reversible and irreversible thermodynamic processes in a fluid is reconsidered from the point of view of observers in different systems of inertia. Although the total momentum and energy of the fluid do not transform as the components of a 4-vector in this case, it is shown that the momentum and energy of the heat supplied in any process form a 4-vector. For reversible processes this four-momentum of supplied heat is shown to be proportional to the four-velocity of the matter, which leads to Ott's transformation formula for the temperature in contrast to the old formula of Planck. (auth) (DENM)

42224 HIDDEN VARIABLES AND MAGNETIC RELAXATION. Wangsness, Roald K. (Univ. of Arizona, Tucson). Phys. Rev., 160: 1190-2(Aug. 25, 1967).

The nonlinear equation proposed by Bohm and Bub to describe the effect of hidden variables is solved for the case of a spin-$\frac{1}{2}$ magnetic moment relaxing in a constant magnetic field. It is found that the observable magnetic components no longer approach equilibrium with a pure exponential time dependence. Some special cases are discussed, and numerical results are obtained for a specific simple example. (auth)

42225 QUANTUM THEORY OF GRAVITY. I. THE CANONICAL THEORY. DeWitt, Bryce S. (Inst. for Advanced Study, Princeton, N. J. Univ. of North Carolina, Chapel Hill). Phys. Rev., 160: 1113-48(Aug. 25, 1967).

Following an historical introduction, the conventional canonical formulation of general relativity theory is presented. The canonical Lagrangian is expressed in terms of the extrinsic and intrinsic curvatures of the hypersurface x^0 = constant, and its relation to the asymptotic field energy in an infinite world is noted. The distinction between finite and infinite worlds is emphasized. In the quantum theory the primary and secondary constraints become conditions on the state vector, and in the case of finite worlds these conditions alone govern the dynamics. A resolution of the factor-ordering problem is proposed, and the consistency of the constraints is demonstrated. A 6-dimensional hyperbolic Riemannian manifold is introduced which takes for its metric the coefficient of the momenta in the Hamiltonian constraint. The geodesic incompletability of this manifold, owing to the existence of a frontier of infinite curvature, is demonstrated. The possibility is explored of relating this manifold to an infinite-dimensional manifold of 3-geometries, and of relating the structure of the latter manifold in turn to the dynamical behavior of space-time. The problem is approached through the WKB approximation and Hamilton-Jacobi theory. Einstein's equations are revealed as geodesic equations in the manifold of 3-geometries, modified by the presence of a "force term." The classical phenomenon of gravitational collapse shows that the force term is not powerful enough to prevent the trajectory of space-time from running into the frontier. The as-yet unresolved problem of determining when the collapse phenomenon represents a real barrier to the quantum-state functional is briefly discussed, and a boundary condition at the barrier is proposed. The state functional of a finite world can depend only on the 3-geometry of the hypersurface x^0 = constant. The label x^0 itself is irrelevant, and "time" must be determined intrinsically. A natural definition for the inner product of two such state functionals is introduced which, however, encounters difficulties with negative probabilities owing to the barrier boundary condition. In order to resolve these difficulties, a simplified model, the quantized Friedmann universe, is studied in detail. In order to obtain nonstatic wave functions which resemble a universe evolving, it is necessary to introduce a clock. In order that the combined wave functions of universe-cum-clock be normalizable, it turns out that the periods of universe and clock must be commensurable. Wave packets exhibiting quasiclassical behavior are constructed, and attention is called to the phenomenological character of "time." The inner-product definition is rescued from its negative-probability difficulties by making use of the fact that probability flows in a closed finite circuit in configuration space. Some speculations are made on the uniqueness of the state functional of the actual universe. It is suggested that a viewpoint due to Everett should be adopted in its interpretation. (auth)

42226 RADIATION OF GRAVITATIONAL WAVES IN BRANS-DICKE GENERAL-RELATIVITY THEORY. O'Connell, R. F. (Goddard Space Flight Center, New York); Salmona, A. Phys. Rev., 160: 1108-10(Aug. 25, 1967).

The rate of radiation of gravitational waves, $P_{BD} \equiv P_T + P_S$, from a system of binary stars is calculated using the general-relativity theory of Brans and Dicke. It is shown that, for a circular orbit, the radiation arises purely from the tensor-field contribution P_T, and P_{BD} is smaller than the corresponding Einstein result P_E, by a factor $(2\omega + 3)/(2\omega + 4)$, where ω is the usual Brans-Dicke dimensionless constant ($\omega \simeq 6$). In the case of an elliptic orbit, there is also a contribution P_S from the scalar field. However, it is shown the contribution of P_S to P_{BD} is always negligible compared to the contribution P_T. Thus it is concluded that, for all values of the eccentricity e, the Brans-Dicke theory predicts that the rate of gravitational radiation from a system of binary stars is always smaller, by a factor of the order of $^{15}/_{16}$, than the rate predicted by Einstein's theory. (auth)

42227 SPIN-1/2 PARTICLES IN A GRAVITATIONAL FIELD. Coulter, C. Alton (Army Missile Command, Redstone Arsenal, Ala.). Amer. J. Phys., 35: 603-10(July 1967).

A recently proposed approach to the formulation of gravitational theory, in which all a priori mention of curvilinear coordinate systems and space–time can be avoided, is illustrated by applying the method to the particular case of the Dirac field. The basic procedure used is that of starting with an invariance property of the special-relativistic free Lagrangian under some class of transformations, identifying the associated conserved "current," and then finding a field which interacts with this conserved current by requiring that the Lagrangian be altered so it remains invariant even when the original transformations become coordinate-dependent in an appropriate fashion. For purposes of illustration, the technique is first used to derive the electromagnetic interaction of the Dirac field, and then the gravitational interaction of this field is worked out. A comparison of the resulting theory with general relativity is given. The emphasis throughout the paper is on concepts rather than on a detailed mathematical development. (auth)

42228 PROBLEMS OF THE QUANTUM THEORY OF MEASUREMENT. Weidlich, W. (Technische Hochschule, Stuttgart). Z. Phys., 205: 199-220(1967).

After a short review of the present situation of the quantum theory of measurement, a formulation of the measuring process is given, which allows an "objective" interpretation. Starting from the unitary time transformation of the states of the measured system S and the measuring device M, it is shown that after appropriate specification of the interaction Hamiltonian H_{int} between S and M and the macroscopic structure of M, the statistical operator W of S + M approximately develops into the mixture, which is desired as result of the measuring process. During the process the interference terms practically vanish in the sense of weak operator convergence, while on the other hand their Hilbert–Schmidt norm remains constant. (auth)

42229 DYNAMICS OF GUIDING IN A DISPERSIVE REFRACTING MEDIUM AND THE THEORY OF ANTIPARTICLES. de Broglie, Louis J. Phys. (Paris), 28: 481-6(May-June 1967). (In French).

A new interpretation of wave mechanics, what could be the "leading motion" of the particle in its wave, as the wave is propagated in a dispersive refracting medium and, especially, when the group velocity has its direction opposite to that of the phase velocity was investigated. The problem of antiparticles is considered in a new way. (auth)

42230 STUDY OF SPECTRAL REPRESENTATIONS FOR SIMPLE QUANTUM-MECHANICAL SYSTEMS. Hellman, W. S.; Roman, P. (Boston Univ.). Amer. J. Phys., 35: 614-24(July 1967).

Spectral representations for two-point functions of point quantum-mechanical systems are derived, under very general assumptions. Sum rules are then obtained, both for systems with velocity independent and dependent interactions. The implications of these sum rules are illuminated on particularized simple systems. Special attention is paid to systems where a zero-frequency (translational) mode exists. The difference between velocity-dependent and -independent interactions is shown to be very crucial in this respect. The same analysis provides an instructive example of inadvertent misuse of the spectral representation. Finally, the possibility of Goldstone behavior, with all its consequences and implications, is demonstrated for systems with finite many degrees of freedom. (auth)

42231 GREEN'S FUNCTION APPROACH TO THE QUANTUM MANY-BODY THEORY OF THE SOLID STATE. Meissner, Guenther (Univ., Tuebingen, Ger.). Z. Phys., 205: 249-71 (1967).

The Green's function approach is used to develop a quantum many-body theory of the solid state which should work at low temperatures as well as in the neighborhood of phase transition points. The theory is applicable also in those cases where the traditional expansion of the potential in powers of the atomic displacements is entirely inadequate (crystalline helium). The starting point of the approach is the concept of broken symmetry since the invariance of the equilibrium ensemble under the continuous group of infinitesimal translations is reduced in a crystalline solid to the invariance under finite translations through a lattice vector. A homogeneous integral equation is derived which has nontrivial solutions in the crystalline state. By this equation it is shown that the umklapp photons are the symmetry restoring collective modes expected due to a general theorem of Goldstone. The single particle excitations and the structure of the Dyson mass operator in the crystalline state are discussed. It is further shown that the homogeneous Bethe–Salpeter equation for the linear response to an external disturbance possesses symmetry breaking solutions which are connected to the lattice dynamics of the solid state. These collective excitations (phonons) are exhibited in RPA and tight-binding approximation for monoatomic cubic crystals with a Bravais lattice in order to demonstrate how the present theory reproduces well-known results. (auth)

42232 THEORIES OF GRAVITATION. Sexl, Roman U. (Univ. of Vienna). Fortschr. Phys., 15: 269-307 (1967).

A systematic study is presented on the theories of gravitation that have been proposed. It is restricted to an investigation of the linear approximation since new connections with experiment can be expected in this order in $\varkappa$ only. It turns out that all theories that differ from general relativity contain a scalar field and describe gravitation by a mixture of scalar and tensor interactions. The scalar has negative energy in theories with light deflection larger than the Einstein value. As a consequence instabilities of cosmic systems and continuous creation result in this case. Furthermore, the emission of gravitational radiation with negative energy could be the energy source of the quasars. The question of the mass renormalization of the scalar is investigated. No unique answer is possible at present. Finally a new class of gravitational theories is given. (auth)

42233 PRIBLIZHENNYE METODY KVANTOVOI MEKHANIKI. (Approximation Methods of Quantum Mechanics). Migdal, A. B.; Krainov, V. P. Moscow, Izdatel'stvo Nauka, 1966. 152p.

Approximation methods of quantum mechanics are reviewed using visual physical concepts. The first chapter is devoted to evaluation of mathematical expressions, derivatives, integrals, differential equations, and the resulting analytical properties of physical values. The second chapter handles various types of perturbation theory (the adiabatic theory, perturbation of boundary conditions, sudden perturbations, etc.). Ionization of atoms in β decay, nuclear reactions, atomic recharge, nuclear excitations, Moessbauer effect, and the infrared catastrophe are discussed as problems of quantum mechanics. The third and last chapter contains quasi-classical approximations for one-dimensional and three-dimensional problems of quantum mechanics (the Thomas–Fermi method, the quasi-classical concept of spherical functions, scattering on the non-central potential, etc.). (R.V.J.)

42234 CONSTRUCTION OF MACROSCOPICALLY LOCAL RELATIVISTIC QUANTUM THEORIES. Nance, Jon Roland. Urbana, Ill., Univ. of Illinois, 1966. 70p.

Thesis.

The problem of providing a physical interpretation of a relativistic quantum theory is discussed. It is shown that a single operator corresponding to a localized measurement on the states of the theory is sufficient for a significant part (perhaps all) of this interpretation. The application of this method of interpretation to the relativistic quantum theory defined on the representation space of an irreducible representation of a higher symmetry group containing the Poincaré group is discussed. It is concluded that the higher symmetry is, in fact, of little use for this interpretation. This leads in a natural way to the problem of finding some of these "quasilocal" operators on the space of states of a given relativistic quantum theory. This problem is specialized to the problem of constructing a model relativistic quantum theory of a certain type. The procedure used is to attempt to construct a representation of the generators of the Poincaré group on the Fock space $\mathfrak{F}$ of real scalar bosons in such a way that quasilocal observables are easily expressible in terms of the canonical creation-destruction operators. The structure of the model permits the construction of the generators to be approached by successively satisfying their structure relations in each of the spaces $\mathfrak{F}(n)$ specified by the eigenvalues of the free field particle number operator. These structure relations are satisfied in $\mathfrak{F}(1)$ and $\mathfrak{F}(2)$. The mathematical details of the problem increase rapidly with n, and no explicit solution is obtained for $n > 2$. Arguments are given which make it plausible that the structure relations in $\mathfrak{F}(n)$, with $n > 2$, may be satisfied by a large class of generators. Several trial solutions in the space $\mathfrak{F}(3)$ are described, and the difficulties associated with them are discussed. (Disser. Abstr.)

42235 RELATIVISTIC DESCRIPTIONS OF MATERIAL SOURCES FOR GRAVITATIONAL FIELDS INCLUDING ELASTIC MATERIALS AS SOURCES OF ASYMMETRIC STATIC FIELDS. Hernandez, Walter Charles Jr. College Park, Md., Univ. of Maryland, 1966. 91p.

Thesis.

Several methods which might be useful for obtaining interior solutions which describe material sources in general relativity were investigated. In the first part the relativistic equations describing spherical gravitational collapse with nonzero pressure are reformulated using observer (retarded) time as the t coordinate. It appears that this choice of t might prevent the computer from running into singularities which it met while attempting to numerically integrate the equations when another (diagonal metric form) t coordinate was used. In the second part two methods for obtaining non-spherically symmetric static interior solutions in general relativity are discussed, in an attempt to learn something about handling nonspherically symmetric problems for later extension to rotating systems. (TSS)

42236 PARADOKS BLIZNETSOV V TEORII OTNOSITEL'NOSTI. (Twin Paradox in the Theory of Relativity). Skobel'tsyn, D. V. Moscow, Izdatel'stvo Nauka, 1966. 192p.

The known paradoxes in the theory of relativity are examined in different variants—the paradox of twins, found after a long flight of one of them in space with velocities close to that of light. By a consideration of this paradox from different points of view, the special and general theories of relativity are introduced. The Lorentz transformation and hypotheses on the space–time relation, resting on the basis of the Einstein theory, are examined. (tr-auth)

42237 FOUNDATIONS OF PHYSICS. Bunge, Mario. Springer Tracks in Natural Philosophy, Volume 10. New York, Springer-Verlag, 1967. 321p. $14.00.

The aims of the book are: (1) to analyze the form and content of some of the key ideas of physics; (2) to formulate several basic physical theories in an explicit and orderly (i.e., axiomatic) fashion; (3) to exhibit their presuppositions and discuss some of their philosophical implications; (4) to discuss some of the controversial issues, and (5) to debunk certain dusty philosophical tenets that obscure the understanding of physics and hinder its progress. (W.D.M.)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Refer also to abstracts 42275–42277.

42238 STATUS REPORT ON HIGH-ENERGY PHYSICS RESEARCH. Van Hove, L. CERN Cour., 7: 130-1(July 1967).

A brief review of the development of high energy physics research is given. Strong, electromagnetic and weak interactions are discussed including the various particle properties, theory, and experiments. (J.F.P.)

Electromagnetic

42239 MEASUREMENTS ON 6.3 GeV ELECTROMAGNETIC CASCADES AND CASCADE-PRODUCED NEUTRONS. Bathow, G.; Freytag, E.; Tesch, K. (DESY, Hamburg). Nucl. Phys., B2: 669-89(1967).

Electromagnetic cascades produced by 6.3-GeV bremsstrahlung in lead, copper and heavy concrete were measured by means of a small ionization chamber. The resulting transition curves were compared with published Monte Carlo calculations. Data were obtained which may prove useful in shielding calculations. Neutrons and other hadrons produced in the cascades were measured by means of activation foils in several energy ranges; the results of these measurements were compared with estimates. Angular neutron distributions are also presented, as well as some data on neutron attenuation in the target material. (auth)

42240 THE CHARGE FROM FACTOR OF THE PROTON AT A MOMENTUM TRANSFER OF 75 fm^{-2}. Bartel, W.; Dudelzak, B.; Krehbiel, H.; McElroy, J. M.; Meyer-Berkhout, U.; Morrison, R. J.; Nguyen-Ngoc, H.; Schmidt, W.; Weber, G. (Deutschen Elektronen-Synchrotron, Hamburg. Inst. Univ., Hamburg). Phys. Lett., 25B: 236-7(Aug. 21, 1967).

The proton form factors $G_E(q^2)$ and $G_M(q^2)$ are determined at $q^2 = 75\ fm^{-2}$. (auth)

42241 SCATTERING OF POSITRONS AND ELECTRONS FROM PROTONS. Bartel, W.; Dudelzak, B.; Krehbiel, H.; McElroy, J. M.; Morrison, R. J.; Schmidt, W.; Walther, V.; Weber, G. (Deutsches Elektronen-Synchrotron, Hamburg. Univ., Hamburg). Phys. Lett., 25B: 242-5(Aug. 21, 1967).

The ratio $R = \sigma(e^+ + p)/\sigma(e^- + p)$ of the elastic scattering cross section of positrons and electrons on protons was measured at momentum transfers of 11.66 fm^{-2} and 35.1 fm^{-2}. The results are consistent with R = 1. (auth)

42242 PROTON COMPTON EFFECT FOR 300-MeV PHOTONS. Gray, E. R.; Hanson, A. O. (Univ. of Illinois, Urbana). Phys. Rev., 160: 1212-15(Aug. 25, 1967).

The scattering of photons by protons was measured with a spark-chamber technique using 335-MeV bremsstrahlung. The experimental values obtained at 90° and 135° are compared with those calculated by Contogouris using dispersion relations. The agreement is reasonable except for a persistently low point for 310 MeV at 90°. (auth)

42243 PHOTOPRODUCTION OF CHARGED PION PAIRS AND $N^*(1238)^{2+}$ IN HYDROGEN FROM 0.9 TO 1.3 GeV. Hauser, M. G. (California Inst. of Tech., Pasadena). Contract AT(11-1)-68. Phys. Rev., 160: 1215-27(Aug. 25, 1967). (CALT-68-123).

The momentum spectrum of negative pions produced in the reaction $\gamma + p \rightarrow \pi^- + \pi^+ + p$ was measured at eight photon laboratory energies from 0.9 to 1.3 GeV at c.m. angles from 7° to 150°. The reaction was produced in a liquid-hydrogen target illuminated by a bremsstrahlung beam from the Caltech synchrotron. The π^- were detected and momentum analyzed with a magnetic spectrometer employing a combination of scintillation counters and Cherenkov counters. The incident photon energy was fixed by using the technique of bremsstrahlung subtraction. The cross section for the pseudo-two-body reaction $\gamma + p \rightarrow \pi^- + N^*(1238)^{++}$ was obtained by fitting the π^- momentum spectrum at each angle and energy with a linear combination of a resonance term and three-body phase space. The angular distribution of the π^- in N^* production shows the small-angle peak and decrease near 0° predicted by the one-pion-exchange (OPE) model. Gauge-invariant models are in poorer agreement with the data. Moravcsik fits to the angular distributions are presented, and are extrapolated to obtain a value for the πNN^* coupling of 23.1 ± 2.0 GeV^{-2}, in fair agreement with the value obtained from the width of the N*(1238). The total cross section for pion pair production decreases smoothly from 78.9 ± 2.9 μb at 0.93 GeV to 59.1 ± 5.2 μb at 1.29 GeV, whereas the N^* part of the cross section decreases from 45.0 ± 2.4 μb to 18.2 ± 3.5 μb over the same range. There is no strong evidence for formation of the N*(1688) as an intermediate state. (auth)

42244 ELECTRON TRIPLETS AND PAIRS OBSERVED IN A STREAMER CHAMBER. Benaksas, D.; Morrison, R. (Stanford Univ., Calif.). Phys. Rev., 160: 1245-51(Aug. 25, 1967). (SLAC-PUB-275).

A study was made of electron pair photoproduction in the field of the nucleus and in the field of the atomic electrons of neon. A streamer chamber, which in many ways behaves as a bubble chamber, was used for this experiment. The recoiling electron is observed and its momentum deduced from its curvature in a magnetic field. Most results agree with theory; in particular the triplet cross section, although the momentum distribution of the recoiling electron seems to fall more rapidly than expected. The results of several tests that have been made in order to determine the usefulness of streamer chambers with incident electron and photon beams are also reported. (auth)

42245 π^+ PHOTOPRODUCTION AT ANGLES FROM 6° TO 90° C.M. AND ENERGIES FROM 589 to 1269 MeV. Ecklund, Stanley Duane. Pasadena, Calif., California Inst. of Tech., 1967. 207p.

Thesis.

The differential cross section for the reaction $\gamma p \rightarrow \pi^+ n$ was measured at 32 laboratory photon energies between 589 and 1269 MeV. At each energy, data were obtained at typically fifteen π^+ cm angles between 6 and 90°. A magnetic spectrometer was used to detect the π^+ photoproduced in a liquid hydrogen target. Two Cherenkov counters were used to reject the background of positrons and protons. The data clearly show the presence of a pole in the production amplitude due to the one pion exchange. Moravcsik fits to the 32 angular distributions, including data from another experiment, are presented. The extrapolation of these fits to the pole gives a value for the pion-nucleon coupling constant of 14.5 which is consistent with the accepted value. The second and third pion-nucleon resonances are evident as peaks in the total cross section and as changes in the shape of the angular distributions. At the third resonance there is evidence for both a D5/2 and an F5/2 amplitude. The absence of large variations in the 0 and 180° cross sections implies that the second and third resonances are mostly produced from an initial state with helicity $\pm\frac{3}{2}$. (Disser. Abstr.)

42246 STUDY OF THE DECAY $\eta \rightarrow \pi^+ \pi^- \gamma$. Price, LeRoy Raymond. Berkeley, Calif., Univ. of California, 1966. 43p.

Thesis.

The results of an analysis of 33 decays of the type $\eta \rightarrow \pi^+\pi^-\gamma$ are presented. It is found that the ρ-dominant model fits the data quite well. No conclusions can be drawn regarding the possible existence of a C-nonconserving interaction. (auth)

Weak

42247 (NP-16947) IZMERENIE UGLOVOI KORRELLATSII PRI RASPADE SVOBODNOGO NEITRONA. (Measurement of Angular e-ν Correlation during Decay of a Free Neutron). No. 483. Grigor'ev, V. K.; Grishin, A. P.; Vladimirskii, V. V. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1966. 20p. (In Russian). Dep.

The electron-neutrino angular correlation was measured by means of proton recoil spectrum shape observation. The result of measurement is: $\lambda = 0.091 \pm 0.039$. Accepting the vector and axial vector types of coupling only, the following ratio of coupling constants is obtained: $|Ga/Gv| = 1.22 \pm 0.08$. (auth)

42248 POSSIBLE VIOLATION OF THE $\Delta S = \Delta Q$ SELECTION RULE IN LEPTONIC DECAYS OF Σ^+ HYPERONS. Eisele, F.; Engelmann, R.; Filthuth, H.; (and others) (Univ., Heidelberg). Z. Phys., 205: 409-19(1967).

A possible example of the rare decay $\Sigma^+ \rightarrow n\mu^+\nu$, which violates $\Delta S = \Delta Q$ was found. The positive decay track of the Σ^+ comes to rest in the hydrogen bubble chamber and decays into an e^+. This track has all the characteristics of a stopping μ^+. The decay neutron fortuitously scatters twice, producing two recoil protons. The only other possible interpretation of the event is $\Sigma^+ \rightarrow n\gamma(\pi^+ \rightarrow \mu^+\nu)$, where the $\pi^+ \rightarrow \mu^+\nu$ decay produces no deflection ($\vartheta < 0.1$ rad) and no significant change in curvature. Using the p-wave radiative decay-predictions of Barshay et al. it is calculated that the inte-

grated branching ratio for such "accidental" events is $\Gamma(\Sigma^+ \to n\gamma(\pi^+ \to \mu^+_{stop}\nu))/\Gamma(\Sigma^+ \to n\pi^+) = 1.6 \times 10^{-4}$. Most of the contribution to this "accidental" branching ratio comes from radiative decays where the π^+ mesons have ranges less than 1 mm (p_π <20 MeV/c). If one excludes those μ's with ranges less than 1.2 cm the above "accidental" branching ratio becomes 5.5×10^{-7}. With this figure it is estimated that one should have seen 6.5×10^{-2} events of this type thus far in the experiment. The neutron momentum does not help in deciding between the two hypotheses. One therefore assigns a confidence level of 7% for the radiative hypothesis. For the leptonic hypothesis an estimate of the branching ratio $\Gamma(\Sigma^+ \to n\mu^+\nu)/\Gamma(\Sigma^+ \to n\pi^+) = 5 \times 10^{-5}$ is obtained. If one further accepts the $\Sigma^+ \to n\mu^+\nu$ event reported by Barbaro-Galtieri et al. and the $\Sigma^+ \to ne^+\nu$ event reported by Nauenberg et al., one obtains the $\Delta S = -\Delta Q$ leptonic branching ratio $[\Gamma(\Sigma^+ \to n\mu^+\nu) + \Gamma(\Sigma^+ \to ne^+\nu)]/\Gamma(\Sigma^+ \to n\pi^+) = (4 \pm 3) \times 10^{-5}$. It should be pointed out that in bubble chamber experiments the radiative background simulating a muonic decay is not negligible. Up to now 0.1 event of this type should have been found in all these experiments. (auth)

42249 RESEARCH ON ANISOTROPY IN THE DECAY OF $\pi-\mu$. Cvijanovich, G. B. (Univ., Bern); Jeannet, E. Helv. Phys. Acta, 40: 688-92(Oct. 1, 1967). (In French).

There are some previous indications of a possible asymmetry in decays of positive pions produced in τ^+ decays. The investigation based on 1062 π^+ decays at rest in photographic emulsions does not show any asymmetry, in agreement with the pseudoscalar nature of pions. (auth)

42250 EVIDENCE CONCERNING THE POSSIBLE EXISTENCE OF AN EXCITED ELECTRON IN THE DECAYS $\pi^+(K^+) \to e^+ + \nu_e$. Barshay, S. (Rutgers-The State Univ., New Brunswick, N. J.); Franklin, A. Phys. Rev., 160: 1294-5(Aug. 25, 1967). (PPAD-606-E).

Experiments on the decays $\pi^+(K^+) \to e^+ + \nu$ were investigated to look for the possible existence of an excited electron (e') with a mass of the order of a few tens of MeV. No evidence for such a particle was found. Assuming an e' mass of $20m_e$ the upper limits for the weak axial-vector coupling constant to the hypothetical excited electron were found to be $(g_{A'}/g_A)_{\Delta S=0} \cong 0.01$ from π^+ decay and $(g_{A'}/g_A)_{\Delta S=1} \cong 0.6$ from K^+ decay. (auth)

42251 ENERGY DEPENDENCE OF THE FORM FACTOR IN K^+_{e3} DECAY. Imlay, R. L. (Princeton Univ., N. J.); Eschstruth, P. T.; Franklin, A. D.; Hughes, E. B.; Reading, D. H.; Bowen, D. R.; Mann, A. K.; McFarlane, W. K. Phys. Rev., 160: 1203-11 (Aug. 25, 1967). (PPAD-617E).

In a spark chamber and counter experiment at the Princeton-Pennsylvania Accelerator the decay $K^+ \to e^+ + \pi^0 + \nu$ was investigated. A Dalitz plot of 1393 K^+_{e3} events agrees well with vector coupling. The π^0 energy spectrum was investigated to determine the energy dependence of the strong-interaction form factor f_+ which is a function of $q^2 = M_{K^2} + M_{\pi^2} - 2M_K E_\pi$ for K^+ decays at rest. For a linear expansion $f_+(q^2) = f_+(0)\,(1 + \lambda q^2/M_{\pi^2})$, $\lambda = 0.016 \pm 0.016$, which agrees well with previous measurements of λ for K^+_{e3}. Assuming the interaction is dominated by a $J = 1^-$, $I = \frac{1}{2}$ intermediate state of mass M, such as the K^* resonance at 890 MeV, $M = (1180^{+\infty}_{-387})$ MeV was obtained. This result is consistent with K^* dominance but also with no energy dependence for f_+. The value of λ for K^+_{e3} obtained in this experiment agrees with the weighted mean value $\langle\lambda^0\rangle = 0.010 \pm 0.018$ obtained from four K^0_{e3} experiments and thus offers no evidence for violation of the leptonic $|\Delta I| = \frac{1}{2}$ rule. (auth)

42252 SIGN OF THE K_1^0–K_2^0 MASS DIFFERENCE. Meisner, Gerald Warren. Berkeley, Calif., Univ. of California, 1966. 51p.

Thesis.

An experiment was performed to measure the sign of $m_1 - m_2$ by following the time development of K^0–p elastic scatters. The K^0_2 was found to be heavier than K^0_1. The statistical confidence level depends on the unresolved Fermi–Yang-type (F-Y) ambiguity that exists at present in the KN (strangeness S = +1) phase shifts in isotopic–spin state I = 0. If the F solution (large positive $p_{\frac{1}{2}}$ phase shift) is correct, one obtains Monte Carlo betting odds of 45 to 1 for $m_2 > m_1$, assuming $|m_1 - m_2| = 0.57\ \tau_1^{-1}$. If instead the Y solution (large positive $p_{\frac{1}{2}}$ phase shift) is correct, the betting odds for $m_2 > m_1$ are 5 to 1. The F-Y ambiguity has not been resolved. (Disser. Abstr.)

42253 TIME-DEPENDENT INTERFERENCE IN NEUTRAL $K \to \pi^+ + \pi^-$ AFTER REGENERATION. Mischke, Richard Evans. Urbana, Ill., Univ. of Illinois, 1966. 111p.

Thesis.

An experiment was performed to investigate the time dependence of neutral $K \to \pi^+\pi^-$ following a regenerator. Data were taken with Cu regenerators of thickness 0'', $\frac{1}{2}$'', $\frac{3}{2}$'', and 3''. The momenta of the charged K decay products were measured in a spark chamber placed in a magnetic field and were analyzed under the assumption of $K \to \pi^+\pi^-$. The proper time distribution of those events with an invariant mass between 485 and 515 MeV/c^2 was found for each thickness. The number of coherent (forward) events in each time bin was found by subtraction of the background level as extrapolated from the angular distribution of the K's at larger angles with respect to the beam direction. The resultant time distributions were fitted to equations to test the hypotheses of interference and no interference between the $K^0_1 \to \pi^+\pi^-$ and $K^0_2 \to \pi^+\pi^-$ amplitudes. The results show the amplitudes are coherent and do interfere. The value found for the mass difference $(m_S - m_L)$ is $\delta = (\pm 0.57 \pm .11)$ $(1/\Gamma_S)$ and for the initial phase between amplitudes is $\Phi = \mp 1.10 \pm .34$ rad. An optical model calculation was performed to relate Φ to the phase of the parameter $\eta_+ = [\langle\pi^+\pi^-|K^0_L\rangle/\langle\pi^+\pi^-|K^0_S\rangle]$, and the result is $\arg \eta_+ = \begin{matrix}-1.90 \\ + .44\end{matrix} \pm .44 \begin{matrix}\delta > 0 \\ \delta < 0.\end{matrix}$ Comparison with other experiments is presented and mention is made of the agreement with the prediction of the TCP theorem and $\Delta I = \frac{1}{2}$ rule that $\arg(\eta_+(1\delta + \frac{1}{2}))$ is real. (Disser. Abstr.)

42254 THE TOTAL MUON POLARIZATION IN $K_{\mu 3}^0$ MESON DECAY. Abrams, Robert Jay. Urbana, Ill., Univ. of Illinois, 1966. 102p.

Thesis.

A spark chamber experiment was performed at the Zero Gradient Synchrotron to study the polarization of the muon in the decay $K^0_2 \to \pi^-\mu^+\nu$. The results of the test of time reversal invariance and the value obtained for the form factor ratio will be presented. The K^0_2 mesons, from the 31° neutral beam, decayed in vacuum in a magnetic field. The momenta of the π^- and the μ^+ particles were measured by means of foil spark chambers inside the magnet. A kinematic reconstruction of the K^0_2 decay was made for each event. In the 1602 events selected, the muon passed through a thick absorber, came to rest in a set of aluminum range spark chambers, and decayed ($\mu^+ \to e^+ + \nu + \bar{\nu}$). The muon polarization was determined from a study of the angular distribution of the decay positrons. Due to a two-fold ambiguity in the kinematic reconstruction, two methods were used to analyze the data. In the first method, unambiguous events were selected; after correcting for efficiencies, a least-squares analysis was performed on the positron angular distributions. The three orthogonal components of the muon polarization were obtained: $\alpha\bar{P}_L = 0.33 \pm 0.04$, $\alpha\bar{P}_T = 0.01 \pm -0.06$, and $\alpha\bar{P}_P = -0.10 \pm 0.08$ where $\bar{P}_L$, $\bar{P}_T$, and $\bar{P}_P$ are, respectively, the components of polarization along the muon momentum, transverse to the decay plane, and perpendicular to the muon (in the decay plane); α is the analyzing parameter of muon decay. In terms of the form factor ratio $\xi = f_-/f_+$, the results were $\mathrm{Re}\ \xi = -1.2 \pm 0.6$ and $\mathrm{Im}\ \xi = 0.1 \pm 0.5$ In the second method of analysis, a Monte Carlo calculation was made to simulate the decay of the K^0_2 meson followed by the decay of the polarized muon. The kinematical ambiguity was treated such as to enable a direct comparison to be made between the Monte Carlo sample and the actual data. The χ^2 analysis in terms of ξ was performed, with the following results $\mathrm{Re}\ \xi = -1.8 \pm 0.5$ and $\mathrm{Im}\ \xi = -0.1 \pm 0.5$ The results of both methods were consistent and in agreement with time reversal invariance, which predicts $\mathrm{Im}\ \xi = 0$. The values obtained for $\mathrm{Re}\ \xi$ imply an energy dependence for the form factors in $K^0_{\mu 3}$ decay. (Disser. Abstr.)

42255 A MEASUREMENT OF THE RELATIVE BRANCHING RATIO $K^+ \to \mu^+ + \nu/K^+ \to \pi^+ + \pi^0$. Beck, Robert Lamar. Berkeley, Calif., Univ. of California, 1966. 64p.

Thesis.

K^+-mesons in a momentum-analyzed beam were identified by a velocity selecting Cherenkov counter and brought to rest in a beryllium target which served as a source for a broad-range magnetic spectrometer. Muons and pions from the decay modes $K^+_{\mu 2} \to \mu^+ + \nu$ (P_μ = 236 MeV/c) and $K^+_{\pi 2} \to \pi^+ + \pi^0$ (P_π = 205 MeV/c) were identified by momentum and range, and a value 2.31 ± .24 for the relative branching ratio Kμ2/Kπ2 was obtained. The value is compared with results of other experiments. (Disser. Abstr.)

42256 A SEARCH FOR HEAVY LEPTONS USING A DIFFERENTIAL CHERENKOV COUNTER. Beier, Eugene William. Urbana, Ill., Univ. of Illinois, 1966. 117p.

Thesis.

A search for heavy leptons was performed at the Alternating Gradient Synchrotron. Particular emphasis was placed on the possible existence of leptons with mass slightly less than the K meson mass. The experiment used a high-resolution differential Cherenkov counter to identify known beam particles and place upper limits on the abundance of other particles in the beam. The details of the design and performance of this Cherenkov counter are given. Heavy leptons of mass near the K meson mass were sought by looking for anomalous penetration of lead by particles identified as K mesons in the differential Cherenkov counter. The result is presented as the 95% confidence limit that there is no anomalous penetration of lead by K mesons. This limit is com-

pared with an estimate of the number of heavy leptons expected as a function of their mass and lifetime and under reasonable assumptions about their production. Total cross sections for 3.05 BeV/c π^- and K^- and 4.60 BeV/c $\bar{p}$ interacting with lead are given. A summary of present limits on the existence of heavy leptons is presented. (Disser. Abstr.)

Strong (Baryon-Induced)

42257 THE POLARIZATION OF 0,95 GeV PROTONS SCATTERED BY CARBON AND ALUMINIUM. Adams, C. J.; Dowell, J. D.; Grayer, G. H. (Univ. of Birmingham, Eng.). Nuovo Cim. (10), 51A: 232-4(Sept. 1, 1967).

A measurement was made of the polarization of 950 ± 5-MeV protons scattered at 7.2° from internal targets of carbon and aluminum. The difficulty of identifying elastic scatters is largely removed by using hydrogen as an analyzer. The asymmetry and mean polarization of protons for each internal target material are given. (J.F.P.)

42258 HIGH-PRECISION MEASUREMENT OF PROTON–PROTON POLARIZATION BETWEEN 10 AND 20 MeV. Slobodrian, R. J.; McKee, J. S. C.; Bichsel, H.; Tivol, W. F. (Univ. of California, Berkeley). Phys. Rev. Lett., 19: 704-5(Sept. 18, 1967).

The p-p polarization asymmetry was measured at 9.6-, 15.6-, and 19.7-MeV laboratory energy with accuracy down to ±0.003. The interpretation of our results requires a significant spin-orbit term in the interaction. (auth)

42259 EXPERIMENTS AT LOW ENERGY. Catillon, P. (CEN, Saclay, France). pp 297-307 of Polarized Targets and Ion Sources. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, [1967].

From Conference on Polarized Targets and Sources, Saclay, France, Dec. 5-9, 1966. See CONF-661205.

A description of the three experiments that have been performed at low energy using polarized targets is given. These experiments, performed at Los Alamos, Harwell, and Saclay, involve the nucleon–nucleon interactions. (W.H.K.)

42260 THE REAL PART OF THE SPIN-INDEPENDENT FORWARD SCATTERING AMPLITUDE IN ELASTIC NUCLEON-NUCLEON COLLISIONS. Dutton, L. M. C.; Howells, R. J. W.; Jafar, J. D.; Van Der Raay, H. B. (Univ. of Birmingham, Eng.). Phys. Lett., 25B: 245-8(Aug. 21, 1967).

Elastic pp and pd scattering in the Coulomb interference region were studied using a sonic spark chamber technique. Analyses of these data yield $\alpha_p = 0.10 \pm 0.16$ and $\alpha_n = -0.50 \pm 0.15$ at 1.69 GeV/c in good agreement with dispersion relation calculations, the value of $\alpha_p = -0.30 \pm 0.09$ obtained at 1.54 GeV/c is however not consistent with these calculations. (auth)

42261 LAMBDA–PROTON INTERACTIONS AT HIGH ENERGIES. Bassano, D. (Syracuse Univ., N. Y.); Chang, C. Y.; Goldberg, M.; Kikuchi, T.; Leitner, J. Phys. Rev., 160: 1239-44(Aug. 25, 1967).

Lambda-proton interactions leading to final states of the types Λp, $\Lambda p 2\pi$, and $\Sigma p \pi$ were investigated in the momentum range ~1–5 BeV/c. Final-state resonance production is discussed in terms of meson-exchange models and inelastic cross sections are estimated. The elastic and total cross sections, averaged over the full energy range, are found to be ~10 mb and ~35 mb, respectively. These values are in good agreement with predictions based on various versions of the quark model. (auth)

42262 SIX- AND SEVEN-PION ANNIHILATION MODES OF 2.7-GeV/C ANTIPROTONS ON PROTONS. Bohning, Daryl Eugene. Ames, Iowa, Iowa State Univ. of Science and Tech., 1966. 62p. (IS-T-115).

Thesis.

The results of an investigation of the annihilation of 2.7 BeV/c antiprotons on protons into six and seven pions are presented. The experiment forming the basis of this investigation was carried out using the 33 BeV Alternating Gradient Synchrotron and the 20″ Shutt liquid hydrogen bubble chamber. A total six-prong cross section of 5.08 ± 0.39 mb is found to be distributed as: $\sigma(\bar{p} + p \rightarrow 3\pi^+ + 3\pi^-) = 1.05 \pm 0.15$ mb, $\sigma(\bar{p} + p \rightarrow 3\pi^+ + 3\pi^- + \pi^0) = 2.18 \pm 0.40$ mb, and $\sigma(\bar{p} + p \rightarrow 3\pi^+ + 3\pi^- + n\pi^0, n \geq 2) = 1.69 \pm 0.55$, the balance going to kaon final states. Rho and ω production in the six and seven pion final states, respectively, are set at 1.0 ± 0.22 mb and 0.5 ± 0.27 mb, with no evidence for f^0 or ρ^z production. In addition, the six pion final state shows some indication of a newly discovered I = 0 meson state at 1670 MeV. From the data this state is estimated to decay to $\rho + \pi^+ + \pi^-$ and $2\pi^+ + 2\pi^-$ in the ratio four to one. Angular distributions and angular correlations are presented along with discussion of their basic features. (Disser. Abstr.)

Strong (Meson-Induced)

42263 (ITEF-470) IZUCHENIE DVYUKHLUCHEVYKH ZVEZD S ELEKTRONNO-POZITRONNYMI PARAMI PRI IMPUL'SE NA-LETAYUSHCHIKH π^- MEZONOV 2,8 GeV/c. (Study of Two-Pronged Stars with Electron-Positron Pairs for an Incident π^- Meson Momentum of 2.8 GeV/c). Erofeev, I. A.; Vladimirskii, V. V.; Tikhomirov, G. D.; Trebukhovskii, Yu. V. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1966. 20p. (In Russian). Dep.

The two-prong stars with the visible proton and accompanied by the γ rays were investigated in the propane-xenon bubble chamber at the incident π^--meson momentum 2.8 GeV/c. The chamber worked without the magnetic field. The χ^2-test was used for the selection of the reaction $\pi^- p \rightarrow \pi^- p 2\gamma$. The presence of the ρ^- and η^0 mesons was shown for this reaction. No statistically significant enough irregularities were observed in the missing mass distribution for the events from the reaction $\pi^- p \rightarrow \pi^- p 2\pi^0$. (J.F.P.)

42264 (UCRL-17683) MEASUREMENT OF THE POLARIZATION PARAMETER IN $\pi^+ p$ SCATTERING FROM 750 TO 3750 MeV/c. Johnson, Claiborne Holt Jr. (California Univ., Berkeley. Lawrence Radiation Lab.). Aug. 1967. Contract W-7405-eng-48. 159p. Dep. CFSTI.

Thesis.

The polarization parameter in $\pi^+ p$ elastic scattering at fifteen lab momenta from 745 to 3747 MeV/c was measured. The positive pion beam was focused on a one-cubic-inch polarized proton target and both final-state particles were detected by scintillation counter hodoscopes. On the basis of their coplanarity and opening angle, elastic events involving polarized protons were distinguished kinematically from background events. The polarization parameter was obtained by observing the asymmetry in counting rates detected when the target was polarized successively parallel and antiparallel to the normal to the scattering plane. These results, combined with those of other experiments, are being used to conduct a phase-shift analysis of the pion-nucleon system at 19 energies from 490 to 1566 MeV (1443 to 2025 MeV total center-of-mass energy). Several comments about this analysis and a tentative solution are presented. This solution is not in disagreement with earlier analyses, but its uniqueness was not yet firmly demonstrated. (auth)

42265 (UCRL-17712) STUDY OF THE Y_1^* RESONANT AMPLITUDES BETWEEN 1660 AND 1900 MeV IN THE REACTION $K^- n \rightarrow \Lambda \pi^-$. Smart, Wesley Mitchell (California Univ., Berkeley. Lawrence Radiation Lab.). Aug. 1967. Contract W-7405-eng-48. 73p. Dep. CFSTI.

Thesis.

The 25-in. deuterium bubble chamber was exposed to a beam of K^- mesons having laboratory momenta between 815 and 1105 MeV/c. The angular distributions and Λ polarizations in the reaction $K^- n \rightarrow \Lambda \pi^-$ were measured in the center-of-mass energy interval 1660 to 1900 MeV. A partial-wave analysis of the angular distributions and polarizations from $K^- n \rightarrow \Lambda \pi^-$ and the total-cross-section data from $K^- p \rightarrow \Lambda \pi^0$ has yielded information on the quantum numbers, resonance parameters, and SU(3) assignments for four Y_1^* resonances. The spin-parity assignments for $Y_1^*(1765)$ and $Y_1^*(2030)$ were confirmed, and the $Y_1^*(1765)$ mass, width, and $\Lambda\pi$ branching ratio were measured as 1772 ± 6 MeV, 129 ± 17 MeV, and 0.15 ± .02 respectively. A tentative spin-parity assignment for $Y_1^*(1660)$ and $Y_1^*(1915)$ was also made. The measurement of the relative signs of the product of the coupling constants, $g_{\bar{K}NY}\, g^*_{\Lambda\pi Y}$, for the four resonant amplitudes has limited their possible assignments to SU(3) multiplets. The $Y_1^*(1765)$ can only be a member of the $\{10^*\}$ or the $\{8\}$ multiplets. If it is a member of the octet, the value of α (the D-F mixing parameter) must be either less than $\frac{1}{2}$ or greater than 1. This SU(3) assignment for $Y_1^*(1765)$ is based on the assumption that $Y_1^*(2030)$ is a member of a $\{10\}$ multiplet. (auth)

42266 ANALYSIS OF A_1 AND A_2 PRODUCTION IN $\pi^- p$ COLLISIONS AT 11 GeV/c. Conte, F. (Univ., Genoa. Istituto Nazionale di Fisica Nucleare, Genoa); Tomasini, G.; Cords, D.; (and others). Nuovo Cim. (10), 51A: 175-90(Sept. 1, 1967).

Production of the A_1 and A_2 mesons is observed in the $\pi^+\pi^-\pi^-$ mass distribution of the reaction $\pi^- p \rightarrow \pi^- p \pi^+ \pi^-$. Comparison of this mass distribution and in general of this reaction with OPEM calculations shows that the enhancement in the A_1 mass region is most likely a resonance and cannot be interpreted as a kinematical effect. The production cross section in the reaction $\pi^- p \rightarrow \pi^- p \pi^+ \pi^-$ is for the A_1-meson (83 ± 18) μb and for the A_2-meson (51 ± 16) μb. An attempt to determine the quantum numbers of the A-mesons was made, but no unique assignments were found due to the large background under the A_1 and A_2 peaks. The decay modes $A_1^- \rightarrow \pi^- +$ neutrals and $A_2^- \rightarrow \pi^- +$ neutrals were observed in the reaction $\pi^- p \rightarrow \pi^- p +$ neutrals. If these decay modes are inter-

preted as $A_{1,2} \rightarrow \pi^0\rho^-$, a decay branching ratio $(A_{1,2} \rightarrow \pi^0\rho^-)/(A_{1,2} \rightarrow \pi^-\rho^0) \approx 1$ is obtained, as expected if the A-mesons have isospin I = 1. The decay mode $A_2^- \rightarrow \eta\pi^-$ is observed, but not the decay $A_1^- \rightarrow \eta\pi^-$. A branching ratio $R = (A_2 \rightarrow \eta\pi^-)/[(A_2 \rightarrow \rho^0\pi^-) + (A_2 \rightarrow \rho^-\pi^0)] = 0.22 \pm 0.09$ is found. (auth)

42267 RHO MESON STRUCTURE. Roos, Matts (CERN, Geneva). Nucl. Phys., B2: 615-47(1967).

The mass and width of ρ mesons of all charges are studied as a function of momentum transfer t in a large compilation of $\pi\pi$ mass histograms from bubble chamber experiments. For small t, the ρ masses are found to be t-dependent, the ρ^+ and ρ^- masses significantly different and the ρ^0 mass strongly reaction-dependent. Significant ω decay into $\pi^+\pi^-$ is found. The detailed structure of the ρ meson is discussed. (auth)

42268 RESONANCE PRODUCTION IN π^+–p INTERACTIONS AT 2.34 GeV/c. Zlateva, A. I.; Penev, V. N.; Shklovskaya, A. I. (Inst. of Physics, Academy of Sciences, Bulgaria). Compt. Rend. Acad. Bulg. Sci., 20: 281-4(1967). (In Russian).

Experimental data on the formation of ρ-mesons and nucleon isobars $N^{*++}_{3/2,3/2}$ (1238) are presented for the following quasi-two-particle processes: (1) $\pi^+ + p \rightarrow \rho^+ + p$; $\rho^+ \rightarrow \pi^+ + \pi^0$ and (2) $\pi^+ + p \rightarrow N^{*++}_{3/2,3/2} + \pi^0$; $N^{*++}_{3/2,3/2} \rightarrow p + \pi^+$. These interactions took place in a 40 cm hydrogen chamber irradiated in a beam of π^+-mesons having a momentum of 2.34 GeV/c. A total of 30,000 photographs were scanned. A total of 108 events involving reaction 1) and 50 events involving reaction 2) were detected. The experimental results were compared with calculated theoretical values for the angular correlations. The best agreement was noted for the case of exchange with a single meson with absorption of energy due to the large transmitted momentum being taken into account. (TTT)

42269 THE TRANSFER DISTRIBUTION OF THE FOUR MOMENTUM OF THE PROTON IN THE π–p INELASTIC INTERACTIONS AT THE INCIDENT ENERGY OF 20 GeV. Andreescu, Ileana; Besliu, Calin; Gavrilas, Mariana; Mihul, Alexandru; Sahini, Mariela; Ciupitu, Eugen (Inst. of Atomic Physics, Bucharest). Compt. Rend., Ser. A and B, 264: 1610-13(June 5, 1967). (In French).

The transfer distribution of the proton in the inelastic interactions of negative pions with protons at 20 GeV was analyzed. The saturation effect previously observed was confirmed. (J.S.R.)

42270 THE MOMENTUM SPECTRA OF SECONDARY PARTICLES IN (π^-,N)-INTERACTIONS AT 7 BeV. Lehar, F.; Petrzilka, V.; Suk, M. (Czech. Technical Univ., Prague). J. Czech. J. Phys., 17: 489–97(1967).

The experimental momentum spectra of secondary π-mesons and protons from the (π^-,N)-interactions at 7 GeV in the laboratory system are compared with the formula given by H. H. Aly, M. F. Kaplon, and M. L. Shen [Nuovo Cim. 32: (1964), 905]. The fit of the linear-exponential distribution, of Maxwell Boltzmann's distribution and of Planck's law was determined for the experimental histograms of the transverse momenta for the same events. The results obtained are discussed. (auth)

42271 K^+p INELASTIC INTERACTIONS AT 2.7 GeV/c. Newman, Riley David. Berkeley, Calif., Univ. of California, 1966. 73p.

Thesis.

An analysis is presented of an exposure of the hydrogen bubble chamber to a 2.65 BeV/c separated K^+ beam. Channel cross sections are presented for K^+p interactions, except those corresponding to a two prong topology. A detailed study is made of the final states $K^0p\pi^+$ and $K^+p\pi^+\pi^-$, which are dominated by the production of K*(891) and N*(1236). The reaction $K^+p \rightarrow K^*p$ is analyzed in terms of a one meson exchange model modified by form factors, and results are compared with data at other energies. The model is found to give a very unsatisfactory account of the energy dependence of K* production. The reaction $K^+p \rightarrow K^{*0}N^{*++}$ is analyzed in terms of a pion exchange model modified to include the effects of absorption in initial and final states. No evidence is found for production of resonant states other than K*(891), N*(1236), and ω. Relations between three body final states of K^+p reactions implied by SU_3 symmetry are derived and tested. (Disser. Abstr.)

42272 REACTION CHANNELS IN THE CAPTURE OF K^- MESONS BY COMPLEX NUCLEI. Patrick, Jack William. Berkeley, Calif., Univ. of California, 1966. 116p.

Thesis.

A total of 13,600 K^--mesons at rest was observed in two nuclear emulsion stacks. The emission of hyperons, pions, and hyperfragments from 3900 of the K^--capture stars was studied extensively. The identification of the hyperons is discussed. Charged Σ-hyperons are emitted from (17.3 ± 1.2) percent of all K^--stars in the completely analyzed stack from which the following figures are quoted. The Σ^+/Σ^- ratio for all stars is 1.08 ± 0.08, while the proportion of stars from which pions are emitted is 0.38 ± 0.05. About 11 percent of all identified charged Σ-hyperons had an energy above 60 MeV, and were therefore attributed to multinucleon reaction channels. The proportion of all multinucleon primary reaction processes may be as high as 46 percent. A detailed examination of the pion-emitting events and of the sign ratio of the mesons had led to an estimate of the probabilities of absorption of Σ-hyperons in the parent nucleus, and to a partition of events between the various single-nucleon reaction channels. On the basis of the Coulomb barrier and Auger electron emission, discrimination is made between K^--capture on light (C,N,O) nuclei and on heavy nuclei (Ag,Br). For the single-nucleon reaction channels it is found that K^--capture by a light nucleus is 1.16 times as likely to produce a pion as a K^--capture by a heavy nucleus. For the multinucleon channels, it is determined that K^--interaction with a light nucleus is 2.36 times as likely to produce a fast ($T_\Sigma > 60$ MeV) Σ-hyperon as interaction with a heavy nucleus. The mechanism of light ($Z < 7$) hyperfragment formation, excluding cryptofragments, is shown by analysis of the pion spectra accompanying the hypernuclear prong to be primarily one of Σ-conversion (80 percent). A study of the relative number of captures on light and on heavy nuclei yielded the result that less than 20 percent of the production of these light hyperfragments took place on heavy nuclei. Further, a limit of 30 percent was placed on the fraction of light hyperfragments produced in multinucleon reactions. Evidence for the Y_1^* (1405) is studied with $\Sigma\pi$ mass spectra from K^--interactions on ^{12}C. The results can be explained on an impulse model without recourse to resonance formation. Production of Y_1^* with a width of <20 MeV is not confirmed. (Disser. Abstr.)

42273 ANALYSIS OF STRANGE PARTICLE RESONANT STATES FROM π^-p INTERACTIONS. Hardy, Lyndon Mauriece. Berkeley, Calif., Univ. of California, 1966. 101p.

Thesis.

The π^-p interactions producing strange-particle final states with an incident laboratory momentum ranging from 1.6 to 4.2 BeV/c were systematically analyzed. These final states are found to be dominated by the production of well-established resonant states. No evidence was seen for the existence of new resonant phenomena. The reactions $\pi^-p \rightarrow Y^0K^{*0}$ and $\pi^-p \rightarrow Y^{0*}K^0$ proceed peripherally. Simple one-particle exchange does not describe the processes $\pi^-p \rightarrow \Sigma^0K^{*0}$ and $\pi^-p \rightarrow \Lambda K^{*0}$. The absorption model gives an adequate fit to the data for these reactions and indicates the dominance of K* exchange over K exchange. (Disser. Abstr.)

42274 PRODUCTION OF $K\bar{K}$ PAIRS IN π^-p INTERACTIONS. Hess, Richard Irwin. Berkeley, Calif., Univ. of California, 1966. 85p.

Thesis.

The 72-inch hydrogen bubble chamber was exposed to a beam of π^- mesons having laboratory momenta of 2.0, 3.1, and 4.0 BeV/c. The final states containing a $K\bar{K}$ pair included many cases of resonance production. In particular evidence was found for production of the ϕ, A_2, D, and E mesons. The cross sections at 3.1 BeV/c are $\sigma(\pi^-p \rightarrow pA_2^-, A_2^- \rightarrow K\bar{K}) = 18 \pm 4$ μb, $\sigma(\pi^-p \rightarrow nA_2^0, A_2^0 \rightarrow K\bar{K}) = 36 \pm 10$ μb, $\sigma(\pi^-p \rightarrow nD, D \rightarrow K^0K^+\pi^-) = 7 \pm 2$ μb, and $\sigma(\pi^-p \rightarrow nE, E \rightarrow K^0K^+\pi^-) = 17 \pm 5$ μb. The reaction $\pi^-p \rightarrow n\phi$ proceeds with a cross section of 30 ± 8 μb at 2.0 BeV/c. The quantum numbers $I^GJ^P = 1^-$ even$^+$ (J = 0 excluded) for the A_2 meson were established though the determination is not conclusive, $I^GJ^P = 0^+1^+$ is favored for both the D and E mesons. (Disser. Abstr.)

Particle Interactions and Properties (Theoretical)

Refer also to abstracts 42557 and 42695.

General

42275 (AED-C–23-13) HIGH ENERGY PHYSICS INDEX. Volume 5, Number 5(1957–2401). (Zentralstelle fuer Atomkern-energie-Dokumentation, Frankfurt am Main (West Germany)). 1967. 172p. Dep.

A bibliography is presented for literature received at DESY. This index covers experimental information on weak, electromagnetic, and strong interactions, strange particles, accelerators, methods, and instruments. Also theoretical information on weak, electromagnetic, and strong interactions, strange particles, symmetry principles, and field theory are covered. Author, report number, and subject indexes are included. (J.F.P.)

42276 (AED-C–23-14) HIGH ENERGY PHYSICS INDEX. Volume 5, Number 6(2402–3072). (Zentralstelle fuer Atomkern-

energie-Dokumentation, Frankfurt am Main (West Germany)). 1967. 243p. Dep.

A bibliography is presented for literature received at DESY. This index covers experimental weak, electromagnetic, and strong interactions, strange particles, accelerators, methods, and instruments. Also theoretical weak, electromagnetic, and strong interactions, strange particles, symmetry principles, and field theory are covered. Author, report number, and subject indexes are included. (J.F.P.)

42277 (AED-C-23-15) HIGH ENERGY PHYSICS INDEX. Volume 5, Number 7(3073-3767). (Zentralstelle fuer Atomkern-energie-Dokumentation, Frankfurt am Main (West Germany)). 1967. 177p. Dep.

A bibliography is presented for literature received at DESY. This index covers experimental information on weak, electromagnetic, and strong interactions, strange particles, accelerators, methods, and instruments. Also theoretical information on weak, electromagnetic, and strong interactions, strange particles, symmetry principles, and field theory are covered. Author, report number, and subject indexes are included. (J.F.P.)

42278 (IS-1600, Paper 6) PHYSICS DIVISION. Spedding, F. H.; Zaffarano, D. J.; Barnes, R. G.; (and others) (Ames Lab., Iowa). 93p.

Research programs on fundamental particle theory, experimental work with bubble chambers, photonuclear cross sections, photoproton experiments, theoretical studies in medium-energy physics, design and operation of FFAG betatrons, nuclear spectroscopy, isotope separator, nuclear theory, electronic structure of crystalline solids and metals, superconductivity, thermal and thermodynamic properties of solids, semiconductors and compounds with variable stoichiometry, magnetic materials (rare-earth metals and rare-earth compounds), optical properties of solids, and neutron scattering in solids are described. (B.G.D.)

42279 ELEMENTARITY. I. Low, Francis E. Comments Nucl. Particle Phys., 1: 52-7(Mar. 1967).

The discussion of elementarity covers particles, poles in scattering amplitudes, elementary particles, and Regge trajectories. The bootstrap and quark models are also described. (J.F.P.)

42280 AN APPLICATION OF THE DISPLACEMENT AND COLLECTIVE VARIABLES METHOD TO THE SCHROEDINGER EQUATION. Yukhnovskii, I. R.; Khomenko, A. A. (Lvov State Univ.). Ukr. Fiz. Zh., 12: 1081-94(July 1967). (In Russian).

Formulas are presented determining the wave function and energy of the basic state of interacting fermion-systems in the displacement and collective variables method. In a displacement transformation an evolution operator $S_\epsilon(t) = \exp -(i/h)\int_{-\infty}^{t}(H_0 + Ve^{\epsilon t})dt$ is given as a product $S_\epsilon(t) = [\exp U_\epsilon(t)]\sigma_\epsilon(t)$ in which exp $U_\epsilon(t)$ is the sum of all the C-functions of the operator $S_\epsilon(t)$, $\sigma_\epsilon(t) = T \exp (i/h)\int_{-\infty}^{t}\Sigma_i(h^2/2m)(\Delta_i + 2\nabla_i U_\epsilon \nabla_i)dt$. The collective variables ρ_k are introduced in which U_ϵ is expressed in the form of a power series and σ_ϵ includes a screened interaction between packets and is expressed in the mixed (ρ_s) representation. Perturbation theory is applied. An expression for the basic state energy is obtained. (auth)

42281 COSMOLOGY AND ELEMENTARY PARTICLES. Ivanenko, D. (Moscow Univ.). Nuovo Cim. (10), 51A: 244-5 (Sept. 1, 1967).

It is pointed out that gravitation being a long-range force, may give information about real cosmological conditions. One can explain them either more directly as boundary conditons or some kind of an effective cosmological force, or indirectly through their eventual effects on the ground-state vacuum. The hypothesis is expressed that firstly all symmetry features of the universe lead to the same asymmetries of the vacuum, and secondly that to all these asymmetries exist corresponding goldstones. (J.F.P.)

42282 SUPERCONVERGENT BOOTSTRAP MODEL. Freund, P. G. O.; Oehme, R.; Rotelli, P. (Univ. of Chicago). Nuovo Cim. (10), 51A: 217-20(Sept. 1, 1967).

A model based on superconvergence relations which essentially amount to a bootstrap is presented. It gives rise to a super-asymmetry which goes beyond the collinear group U(6) × O(2). Two sets of nonets which may be viewed as S- and P-wave bound states of the quark-antiquark system are considered. (J.F.P.)

42283 REMARKS ON THE COMPOSITENESS CONDITIONS FOR PARTICLES WITH IDENTICAL QUANTUM NUMBERS. Kang, K. (Brown Univ., Providence). Nuovo Cim. (10), 51A: 205-7(Sept. 1, 1967). (NYO-2262TA-159).

It was previously proposed that $\lim_{s\to\infty}$ s det Z(s) = 0 is the second compositeness condition other than det Z = 0, which makes one of the two particles having the same quantum numbers composite. In particular, it is claimed that the second compositeness condition is equivalent to $Z_{11} = [g_1 d(m_1^2)/g_2 d(m_2^2)]\, Z_{12}$, $Z_{22} = [g_2 d(m_2^2)/g_1 d(m_1^2)]\, Z_{12}$, (1). This claim is examined, and it is pointed out how det Z(s) behaves under (1). (J.F.P.)

42284 EQUIVALENT REPRESENTATIONS OF THE DIRAC EQUATION. Saavedra, I. (International Centre for Theoretical Physics, Trieste, Italy). Nucl. Phys., B2: 690-6(1967).

A simple analogy between Foldy-Wouthuysen transformations and two-dimensional rotations is pointed out and from that a new (equivalent) form of the Dirac Hamiltonian is obtained. It is shown that this Hamiltonian is suitable for the discussion of massless fermions, the corresponding wave functions in the new representation being directly given in terms of two-component spinors. (auth)

42285 ELEMENTARITY. II. Low, F. E. (Massachusetts Inst. of Tech., Cambridge). Comments Nucl. Particle Phys., 1: 85-8(May 1967).

The discussion of elementarity includes bootstrap theory in which the Chew-Frauschi bootstrap hypothesis, that all particles lie on Regge trajectories, is formulated. The theory of quarks and that of local currents are also covered. (J.F.P.)

42286 SUPERCONVERGENCE. Low, F. E. (Massachusetts Inst. of Tech., Cambridge). Comments Nucl. Particle Phys., 1: 125-7(July-Aug. 1967).

Superconvergence relations are considered for an amplitude for the process a + b → c + d, where the amplitude satisfies an unsubtracted fixed momentum transfer dispersion relation. The superconvergence relation for the previously considered problem of $\pi + \rho$ scattering is also considered. A few directions in which these superconvergence sum rules can lead are pointed out. (J.F.P.)

42287 SPINNING PARTICLES. Sutton, A. M. (Yeshiva Univ., New York). Phys. Rev., 160: 1055-64(Aug. 25, 1967).

There exist classical systems whose canonical quantization yields relativistic wave equations. As a constructive proof, the classical mechanics of a translating-rotating five-frame is considered. Its quantization yields the Dirac, Weyl, Klein-Gordon, Maxwell-Proca, and higher-spin equations, together with a rotational mass spectrum for the states predicted. The motion of the free classical particle is studied, its anomalous behavior shedding light on the general breakdown of the probability interpretation of relativistic wave equations. Interactions are next discussed. Electromagnetic interactions, in Maxwell field and Fokker action-at-a-distance formulations, yield a theory that is the classical analog of quantum electrodynamics. Point-contact interactions between particles are contemplated, and it is shown that, at the classical level, it is impossible to formulate these in a Lorentz-invariant way. In addition, it is found that many-body systems are subject to constraint ideals, constituting irreducible modules under the action of the symmetric group. These features suggest that a correct quantum treatment of interactions may encounter unanticipated complexity. The conjectured interpretation of the theory, and its connection with gravitation, are briefly discussed. A mathematical principle relating ordinary differential equations to families of linear partial differential equations is given, which is further illustrated in the case of the Cauchy-Riemann equations of analytic function theory. (auth)

42288 BOUNDED-MOMENTUM TRANSFER RESTRICTIONS ON HIGH-ENERGY INTERACTIONS. Zachariasen, F.; Zweig, G. (California Inst. of Tech., Pasadena). Phys. Rev., 160: 1322-5 (Aug. 25, 1967). (CALT-68-115).

A discussion is given of experimental implications of the hypothesis that production cross sections die off rapidly with an increase in any of the independent invariant momentum transfers in the process. Consequences are presented for both high-energy laboratory and cosmic-ray conditions. The results are consistent with existing evidence. (auth)

42289 SPIN CORRELATION MEDIATED BY A SPINLESS PARTICLE. Peres, Asher (Univ. of Maryland, College Park). Phys. Rev., 160: 1549-50(Aug. 25, 1967).

A process is considered in which a neutral spinless particle decays into a charged spin-1 particle V^+ and a charged spin-0 particle. The latter then decays into a V^- and another neutral spinless particle. It is shown that the spins of the V^+ and V^- are correlated. This correlation, however, becomes vanishingly small as soon as it is possible to decide whether the V^+ or the V^- was emitted first. (auth)

42290 SOME REMARKS ON HIGH ENERGY INELASTIC PROCESSES. Czernawski, Dymitr S. (Inst. of Physics, Moscow). Postepy Fiz., 18: 247-66(1967). (In Polish).

The theory of peripheral interactions and some problems connected with the statistical model of multiple production are considered. Fireball production is discussed at length. (auth)

42291 PARTLY GENTLE PERTURBATION WITH APPLICATION TO PERTURBATION BY ANNIHILATION–CREATION OPERATORS. Krohn, Jan Raphael Hoegh. New York, New York Univ., 1966. 81p.

Thesis.

The notion of partly gentle perturbation, an extension of Friedrichs' notion of gentle perturbation, was introduced by P. A. Rejto. For a self-adjoint operator H_0 with an absolutely continuous spectrum. Friedrichs uses the notion of gentle perturbation to prove that for small values of λ the perturbated operator $H = H_0 + \lambda V$ also has an absolutely continuous spectrum and is unitarily equivalent with H_0, provided that V satisfies certain gentleness conditions. Rejto considered the case where H_0 has an absolutely continuous spectrum only in a certain interval I, and by using resolvent methods he was able to give conditions on V such that the perturbated operator H also has an absolutely continuous spectrum in the interval I, and the parts of the operators H_0 and H corresponding to I are unitary equivalent. Rejto called perturbations of this type partly gentle perturbations. Among his conditions on V was the requirement that V be finite dimensional. Later he was able to relax this condition to a condition about V being "compact" in a certain sense. A modified form of the condition of partial gentleness is introduced which does not involve any compactness property on V, and it is proved under this condition that for small λ; both H_0 and $H = H_0 + \lambda V$ have absolutely continuous spectrum in I, and that the parts of H_0 and H corresponding to the spectral in I are unitarily equivalent. The partial gentleness condition is expressed in terms of the kernel of V with respect to the spectral representation of H_0. The previous result is applied to the perturbation of the negative Laplacian by a multiplication operator. It turns out that, under quite general assumption on the multiplication operator, that this perturbation is gentle on the whole real axis; thus it is found that for small λ the perturbated and unperturbated operators are unitarily equivalent. Perturbation by annihilation-creation operators is considered. The undisturbed operator H_0 is described with reference to a particular representation of the Hilbert space, the so called "particle representation," also sometimes referred to as the "Fock representation"; and the disturbing operator V is built up in terms of annihilation and creation operators. A characteristic feature of this type of perturbation problem is that the disturbance increase as the "particle number" increases. Only the case where the free field has a positive mass, is considered, so that large particle number corresponds to large spectral values of H_0. Therefore the disturbance will increase as the spectral value of H_0 increases. Hence only for any bounded part of the spectrum of H_0, can one make the disturbance small by making the perturbation parameter λ small. For this reason the notion of partly gentle perturbation is essential in this case. Also since the disturbing operator V is built up in terms of annihilation and creation operators, V cannot be expected to be compact in any sense, and therefore Rejtos' condition for partly gentle perturbation cannot be applied in this case. It is proven that with the modified condition, that if V contains no pure annihilation or pure creation part, then under suitable smoothness condition on V, and if V is at most quadratic in the boson fields; the perturbation $H = H_0 + \lambda V$ is gentle in every bounded interval. (Disser. Abstr.)

42292 SPECIAL PROBLEMS IN HIGH ENERGY PHYSICS. Sixth International Proceedings, Schladming, Austria, Feb. 26–Mar. 9, 1965. Urban, Paul (ed.). Acta Phys. Austr., Suppl. IV, 1-359(1967). (CONF-670216).

The conference included 13 papers. Separate abstracts were prepared for the 12 complete papers. The other paper on Coulomb fission by very heavy ions was in abstract form only. (J.F.P.)

For abstracts of individual papers see: 42293, 42298, 42299, 42327, 42337, 42338, 42362, 42404, 42432, 42433, 42454, and 42694.

42293 MACH'S PRINCIPLE AND ELEMENTARY PARTICLES. Bergmann, O. (George Washington Univ., Washington D. C.). Acta Phys. Austr., Suppl. 4, 288-308(1967).

From 6th International Proceedings on Special Problems in High Energy Physics, Schladming, Austria, Feb. 26–Mar. 9, 1965. See CONF-670216.

The discussion of the Mach principle and elementary particles covers the Mach principle in classical physics, and it is shown how the cosmological constant may be used to satisfy in part the Mach principle. (J.F.P.)

Electromagnetic

Refer also to abstract 42332.

42294 (ITEF-469) OB ANALOGII MEZHDU ELEKTROMAGNITNYM I IZOTOPICHESKIM RASSHCHEPLENIYAMI MASS. (Analogy Between Electromagnetic and Isotopic Disintegration of Masses). Grigor'ev, V. K. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1966. 7p. (In Russian). Dep.

It was shown that electromagnetic mass difference of $\frac{1}{2}^+$ octet particles satisfied the relation analogous to the Gell-Mann relation for isotopic mass difference. (J.F.P.)

42295 ASYMPTOTIC BEHAVIOR OF THE NUCLEON ELECTROMAGNETIC FORM FACTORS. Chiu, C. B. (Univ. of California, Berkeley); Der Sarkissian, M. Nuovo Cim. (10), 51A: 235-8(Sept. 1, 1967).

Certain assumptions, previously made in a discussion of the asymptotic behavior in momentum transfer for the nucleon electromagnetic form factors leading to a sum rule which is really a superconvergence relation, are clarified. Also the limitations these assumptions impose on the strength of the conclusions drawn in this previous work are considered. The usual language for fitting form factor data by a pole approximation into a form that reveals more clearly the connection with superconvergence relations is recast. Finally it is pointed out that if the Pauli form factors for the nucleon satisfy a certain asymptotic constraint, there must exist an infinite number of vector mesons with different masses and with all other quantum numbers the same. (J.F.P.)

42296 NEAREST-SINGULAIRTY MODEL FOR VECTOR-MESON PHOTOPRODUCTION. Graffi, S. (Univ., Bologna); Selleri, F. Nuovo Cim. (10), 51A: 221-6(Sept. 1, 1967).

A model directly suggested by the analyticity properties of the S-matrix and by the philosophy of dominance of the nearest singularities is presented for the interactions $\gamma + p \rightarrow \rho^0 + p$, $\gamma + p \rightarrow \omega^0 + p$, and $\gamma + p \rightarrow \phi + p$. This model can give rise to a large matrix element for the first interaction and not contribute to the second and to the $\pi + N \rightarrow \rho + N$ interactions since these processes can both be explained by the OPE model and form factors. In the model considered the first interaction is explained as a two-pion exchange process and the second as an OPE process. (J.F.P.)

42297 MINIMAL COUPLING, CURRENT COMMUTATORS AND THE LOW-ENERGY THEOREMS ON PHOTOPION PRODUCTION. Ragusa, S. (Univ. of Chicago). Nuovo Cim. (10), 51A: 118-27(Sept. 1, 1967).

The photoproduction of pions on nucleons is studied in the framework of the algebra of currents and the partially conserved axial-vector current, modified in the presence of electromagnetic interactions. The Kroll–Ruderman theorem, the q_0/M (ratio of the pion cm system energy to the nucleon mass) correction to the s-wave and the P-wave (Klein) theorem, according to which the P-wave production is given near threshold by the Born approximation computed with the actual meson-nucleon coupling constant and magnetic moment. (auth)

42298 DIVERGENCE EQUATIONS AND CURRENT ALGEBRA. Nauenberg, M. (Univ. of California, Santa Cruz). Acta Phys. Austr., Suppl. 4, 98-117(1967).

From 6th International Proceedings on Special Problems in High Energy Physics, Schladming, Austria, Feb. 26–Mar. 9, 1965. See CONF-670216.

The contributions of electromagnetic and weak interactions to the divergence of the hadron currents is covered. This study is undertaken in order to extend these ideas to include the dynamics of the hadrons. It is not a priori clear which viewpoint leads more readily to useful generalization. Also the divergence method sheds light on certain confusion which has arisen in connection with the singular behavior of equal-time commutators of currents, the Schwinger term. Finally the divergence conditions help clarify the underlying assumptions of current algebra. A brief review of current algebra is given, and photoproduction of pseudoscalar mesons and the gauge condition, and the divergence equations are considered. (J.F.P.)

42299 MESON DECAYS. Brown, Laurie M. (Northwestern Univ., Evanston, Ill.). Acta Phys. Austr., Suppl. 4, 4-38(1967).

From 6th International Proceedings on Special Problems in High Energy Physics, Schladming, Austria, Feb. 26–Mar. 9, 1965. See CONF-670216.

Some techniques and ideas useful in the phenomenological analysis of meson decay are introduced and illustrated. The emphasis is on the kinematical aspects, and the form factors (or vertex functions) are briefly discussed. (J.F.P.)

42300 THEORY OF CHARGE TRANSFER IN HIGH ENERGY COLLISIONS. McCarroll, R.; Salin, A. (Observatoire de Paris, Meudon, France). Proc. Roy. Soc. (London), Ser. A, 300: 202-9(Aug. 30, 1967).

A new theoretical treatment of charge exchange is developed

from the Faddeev–Lovelace equations for three-body scattering, by means of the simplifications recently proposed by Dodd & Greider. Detailed consideration is given to the process of electron capture by protons in atomic hydrogen, and a rigorous first-order expression for the scattering amplitude is subsequently derived. It is shown that the high-energy form of the total cross section is that given by the second Born approximation. It is further established that previous treatment of charge-exchange based on the impulse approximation and the continuum distorted wave approximation may be deduced from the present theory by making certain additional assumptions. These assumptions are of questionable validity except at very high energies. (auth)

42301 THE SIZE OF THE NUCLEON AND ρ-MESON DOMINANCE. Wilson, R. (Harvard Univ., Cambridge, Mass.). Comments Nucl. Particle Phys., 1: 104-7(May 1967).

A review of the theory for the size of the nucleon, and meson (ρ) dominance of the isovector form factor is given. Experimental evidence is also considered. (J.F.P.)

42302 SUPERCONVERGENCE AND THE CALCULATION OF ELECTROMAGNETIC MASS DIFFERENCES. Drell, S. D. (Stanford Univ., Calif.). Comments Nucl. Particle Phys., 1: 94-8 (May 1967).

A review of the clarification of puzzles in the electromagnetic mass differences between hadrons within a given isospin multiplet is presented. The essential ideas of Harari are given. (J.F.P.)

42303 NEW LOW-ENERGY THEOREM FOR COMPTON SCATTERING. Singh, Virendra (Rockefeller Univ., New York). Phys. Rev. Lett., 19: 730-4(Sept. 18, 1967).

A low-energy theorem is derived for pion Compton scattering giving terms of second order in photon frequency. This is then used to derive the value of the low-energy parameters. The low-energy theorem is also converted into a sum rule and a resonance saturation is attempted. (auth)

42304 DOES CHARGE OBEY A SUPERSELECTION RULE? Rolnick, William B. (Wayne State Univ., Detroit). Phys. Rev. Lett., 19: 717-18(Sept. 18, 1967).

It was previously pointed out that a superselection rule can be tested by allowing a particle to interact with two parts of a system under the following circumstances. The incident particles and other systems as a whole may be eigenstates of the additively conserved quantum number. The conditions under which an apparatus could be constructed to test the superselection rule are described. It is pointed out that if such an apparatus could be constructed, it would immediately prove that charge does not obey a superselection rule. (L.B.S.)

42305 ON THE COMPTON GRAPH CONTRIBUTION TO THE e^+e^- AND $\mu^+\mu^-$ PAIR PHOTOPRODUCTION CROSS SECTION. Ter-Martirosyan, K. A.; Boreskov, K. G. (Inst. for Theoretical and Experimental Physics, Moscow). Phys. Lett., 25B: 223-4 (Aug. 21, 1967).

The Compton graph contribution to the e^+e^- and $\mu^+\mu^-$ pair production cross section is estimated, using the general form of the 0° Compton effect matrix elements, and under symmetric conditions when there is no interference between the Bethe–Heitler matrix element and the Compton matrix element. The results are compared with experiment as a check of the validity of quantum electrodynamics. (L.B.S.)

42306 COMBINED METHOD FOR THE INVESTIGATION OF TWO-PHOTON ANNIHILATION OF POSITRONS. Arifov, P. U. (Physical-Technical Inst., Tashkent). Dokl. Akad. Nauk. Uzb. SSR, No. 12, 14-17(1966). (In Russian).

Geometries for experiments on angular correlation are proposed. These geometries make it possible to improve the conditions of collection of statistics. A very simple scheme for the recording of triple coincidences in combined experiments is also suggested which allows the spectrum of the pair to be constructed for each decay mechanism. (tr-auth)

42307 PAIR PRODUCTION BY PHOTONS ON ELECTRONS. Mork, K. J. (National Bureau of Standards, Washington, D. C.). Phys. Rev., 160: 1065-71(Aug. 25, 1967).

The cross section for production of electron pairs by unpolarized photons in the field of an electron is calculated. The total section is obtained by numerical integration. The contributions to the total cross section from different diagrams (exchange and γ-e terms) are calculated separately, and it is shown that Borsellino's result for the cross section is valid for photon energies above about 8 MeV, the deviation from the correct cross section being of order 1% at this energy. Votruba's results for the total cross section are confirmed for energies very close to threshold (within about 10 keV of threshold). The results of Kopylov et al. appear to be in error by a factor of 2. Dividing their results by this factor, agreement is found within limits of error. The recoil momentum distribution is computed numerically for some energies and it is found to agree with the results of Borsellino. At high energies it is also in agreement with the results of Suh and Bethe. The momentum distribution for pair production in the field of a very heavy particle is also calculated for some energies from the formulas of Borsellino and Jost et al. From a comparison of the recoil distributions for pair production on electrons with that on very heavy particles, an estimate of the error in the Wheeler-Lamb results can be made. Comparison with some experiments is given. (auth)

42308 CLASSICAL THEORY OF MAGNETIC CHARGE. Yan, Tung-mow (Harvard Univ., Cambridge, Mass.). Phys. Rev., 160: 1182-6(Aug. 25, 1967).

A classical theory of magnetic charge is formulated on the basis of an action principle. It is an extension of Schwinger's quantum theory of magnetic charge to the classical level. The action integral is defined by limiting procedure to ensure the equivalence of all singularity lines. The action principle gives correct equations of motion for the particles, Maxwell's equations, and the conservation laws of the Lorentz group. The consistency of the theory demands a charge-quantization condition, and the existence of a constant with the dimensions of action. (auth)

42309 SUPERCONVERGENCE SUM RULE FOR NUCLEON MAGNETIC MOMENT. Choudhury, S. Rai; Nussinov, S. (Princeton Univ., N. J.). Contract AF49(638)-1545. Phys. Rev., 160: 1334-5(Aug. 25, 1967).

A superconvergence sum rule relating the nucleon magnetic moments to an integral over a photoproduction amplitude is deduced. A careful evaluation of the sum rule shows that it is in moderately good agreement with experiment. (auth)

42310 HIGH-ENERGY LIMIT OF PHOTON SCATTERING ON HADRONS. Abarbanel, Henry D. I. (Princeton Univ., N. J.); Low, F. E.; Muzinich, I. J.; Nussinov, Shmuel; Schwarz, John H. Contract AF49(638)-1545. Phys. Rev., 160: 1329-33(Aug. 25, 1967). (MIT-2098-322).

It is shown that the presence of a fixed pole at $J = 1$ in the process $\gamma + \gamma \to h + \bar{h}$ reinstates the coupling of the γ-γ state to the vacuum trajectory, and hence permits a finite total photon cross section as $s \to \infty$. (auth)

42311 HIGH-ENERGY PHOTOPRODUCTION BRANCHING RATIOS IN THE REGGE-POLE MODEL. Ahmadzadeh, A.; Jacob, R. J. (Arizona State Univ., Tempe). Phys. Rev., 160: 1359-62(Aug. 25, 1967).

Photoproduction of pseudoscalar, vector, and tensor mesons at high energies is formulated in a Regge-pole model incorporating SU(3) symmetry. The exchanged Regge poles are the vector and tensor trajectories satisfying broken SU(3) and unbroken SU(3) couplings with the same classification as given previously. From this formalism simple branching ratios are predicted which can be tested with future experimental results. (auth)

42312 MODELS OF $\eta^0 \to \pi^0 + 2\gamma$ DECAY. Oppo, Giuseppe (Polytechnic Inst. of Brooklyn, N. Y.); Oneda, S. Phys. Rev., 160: 1397-1406(Aug. 25, 1967).

Recent experimental results on the $\eta^0 \to \pi^0 2\gamma$ decay indicate that the branching ratio $B \equiv \Gamma_\eta(\pi^0 2\gamma)/\Gamma_\eta(\pi^+\pi^-\gamma)$ is of the order of (or compatible with) 1. Using the vector-meson-dominant model, the width and the pion energy spectrum of the $\eta^0 \to \pi^0 2\gamma$ decay are computed, using the relevant SU(3)-symmetric coupling constants, including the ω-ϕ mixing hypothesis as given by the static SU(6) theory, which demands $\Gamma_\eta(\pi^0\gamma) \approx 0$. The effect of varying the mixing angle and the effective coupling constant $f_{\phi\pi^0}$ around the static SU(6) value is studied over a wide range compatible with the present experimental information, using as input the experimental $\Gamma_\eta(\pi^0\gamma)$ as before. The model gives $B \approx 0.331 \times 10^{-2}$ at the static SU(6) value, which increases by a factor of 10 at the mixing angle of 20°. It therefore appears that unless there is a drastic decrease in the experimental branching ratio, the vector-meson-dominant model cannot provide a dominant mechanism for the $\eta^0 \to \pi^0 2\gamma$ decay. A remark is also made about the relation between the value of the ω-ϕ mixing angle and the ratios of various observed decay rates. An alternative simple mechanism for the $\eta^0 \to \pi^0 2\gamma$ decay which may be suggested by the tadpole model of the electromagnetic mass difference of hadrons is also studied. The existence of the I = 1, normal 0^+ $(\eta\pi)$ resonance ϵ is assumed, and the intermediary of the ϵ meson $\eta^0 \to \pi^0\epsilon^0 \to \pi^0 2\gamma$ is considered. Some consequences of this model are discussed. (auth)

42313 CALCULATION OF THE N*(1238) ELECTROMAGNETIC MASS DIFFERENCES BY S-MATRIX METHODS. Henyey, Frank S. (California Inst. of Tech., Pasadena). Contract AT(11-1)-68. Phys. Rev., 160: 1449-58(Aug. 25, 1967). (CALT-68-115).

The electromagnetic mass differences within the N*(1238) iso-

multiplet were calculated, using the S-matrix theory of perturbations developed by Dashen and Frautschi. An ambiguity in the choice of methods for calculating the effect of one-photon exchange, and the lack of sufficient data on the ρ meson, lead to rather large uncertainties in the predicted mass differences. The results are consistent with experimental determinations of the differences, which also have rather large uncertainties. (auth)

42314 CONSPIRACY AND SUPERCONVERGENCE IN PION PHOTOPRODUCTION. Halpern, M. B. (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., 160: 1441-6(Aug. 25, 1967).

Pion photoproduction, especially at t = 0, is studied, with particular reference to the conspiracy condition and the superconvergence relation that should apply at that point. (auth)

42315 DECAY $\eta \rightarrow 2\pi + 2\gamma$ AND CURRENT ALGEBRA. Dreitlein, J.; Mahanthappa, K. T. (Univ. of Colorado, Boulder). Phys. Rev., 160: 1542-5(Aug. 25, 1967).

The decay $\eta \rightarrow 2\pi + 2\gamma$ is studied with the use of current-algebra techniques. The possibility that this mode simulates the 3π-decay mode of the η meson and thereby resolves the discrepancy between the experimental and theoretical values of the branching ratio $\Gamma(\eta \rightarrow \pi^+\pi^-\pi^0)/\Gamma(\eta \rightarrow 3\pi^0)$ is considered. Although the digamma spectrum in the decay $\eta \rightarrow 2\pi + 2\gamma$ simulates the digamma spectrum in the decay of π^0 (involved in the final state of the decay $\eta \rightarrow 3\pi$) very well, the predicted rate of $\eta \rightarrow 2\pi + 2\gamma$ is too small to resolve the discrepancy. The definite prediction for the decay rate for $\eta \rightarrow 2\pi + 2\gamma$ is offered as a test of current algebra, as this mode does not involve some of the ambiguities contained in other applications. (auth)

42316 η DECAY WITH A C-VIOLATING $\eta\rho\pi$ INTERACTION. Fujii, Yasunori (Tokyo Univ.); Shaw, Gordon L. Phys. Rev., 160: 1551-4(Aug. 25, 1967).

One of the important tests for the presence of a C-violating semistrong interaction occurs in the decay $\eta \rightarrow \pi^+\pi^-\pi^0$. A previously suggested model is examined in which a π^+-π^- asymmetry is produced by the interference of the dominant mode $\eta \rightarrow \sigma\pi^0$ (where σ is an attractive I = 0, S-wave $\pi^+\pi^-$ state) with the C-violating $\Delta I = 0$ transition $\eta \rightarrow \rho\pi$. The $\eta \rightarrow \rho\pi$ amplitude involves three terms in which each $\pi\pi$ combination goes through a ρ state; enormous cancellation occurs and thus the resultant is sensitive to small perturbations. It is found: (i) that consideration of the finite width of the ρ and the $\pi^+\pi^0$ mass difference greatly alters the distribution of the π^+-π^- asymmetry in the Dalitz plot from that of previous calculations; (ii) that the π^+-π^0 mass difference increases the magnitude of the π^+-π^- asymmetry for a given C-violating coupling $g_{\eta\rho\pi}$. (auth)

42317 SCATTERING OF POLARIZED PHOTONS BY FREE MAGNETIC MOMENT. Kukanov, A. B.; Amer, A. A. (Moscow State Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 4, 75-81 (1967). (In Russian).

Formulas were obtained for differential effective cross sections of elliptically polarized radiation scattering on a free initially quiescent magnetic moment with oriented spin. A detailed study was made of cases in which the incident radiation is linearly and circularly polarized. A case of nonpolarized incident radiation was also investigated. The formulas obtained were used for studying polarization of scattered radiation as a function of incidence and orientation polarization of magnetic moments. (tr-auth)

42318 NUCLEON WAVE FUNCTIONS IN THE PLANE ELECTROMAGNETIC WAVE FIELD. Baranov, I. G. (Nizhniy-Tagil State Pedagogical Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 4, 46-9(1967). (In Russian).

A precise solution of Dirac equation was obtained for nucleons moving in the field of a plane electromagnetic wave in a definite system of coordinates. (tr-auth)

42319 COVARIANT DESCRIPTION OF SPIN STATES OF THE FERMI PARTICLES MOVING IN EXTERNAL FIELDS. Ternov, I. M.; Bagrov, V. G.; Bordovitsyn, V. A. (Moscow State Univ. Tomsk Order of Labor Red Banner Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 4, 41-5(1967). (In Russian).

Covariant spin operators for Fermi particles were investigated. The problem of selection of spin integrals for particles moving in constant and isotropic electromagnetic fields was resolved. Spin integrals of motion for particles with anomalous magnetic moments were studied. (tr-auth)

42320 ELECTROMAGNETIC RADIATION OF NEUTRAL FERMI PARTICLES MOVING IN EXTERNAL FIELDS. Ternov, I. M.; Bagrov, V. G.; Kruzhkov, G. M.; Khapaev, A. M. (Moscow State Univ. Tomsk Order of Labor Red Banner Polytechnic Inst., USSR. Tomsk State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 4, 30-4(1967). (In Russian).

Neutral Fermi particles with anomalous magnetic moment moving in constant and uniform electric and magnetic fields were studied. The possibility of photon emission by particles was established and radiation polarization was investigated. The relation between the emission and spin-flip was found. (tr-auth)

42321 UNITARY IMPULSE APPROXIMATION WITH APPLICATION TO PION–NUCLEON SCATTERING. Finkel, Robert Warren. New York, New York Univ., 1966. 87p.

Thesis.

A generalization of the impulse approximation, which automatically satisfies unitarity conditions in two- and three-body channels, is determined from linear integral equations of the Heitler form, with the K matrix replaced by the ordinary impulse approximation. In a model three-body potential problem, the unitary impulse approximation is found to be a significant improvement over the ordinary impulse approximation when multiple scattering effects are important. The method is applied to pion-nucleon collisions in the second and third resonance regions. The input to this calculation is an impulse approximation to pion-nucleon scattering with a rho resonance formula for the subordinate pion-pion interaction. All the complications of spin and isospin are retained and no adjustable parameters are introduced. Resonant behavior is found in the 600 MeV and 900 MeV neighborhoods. In these respective regions, the impulse approximations for the d_{13} and F_{15} amplitudes exceed unitarity bounds; this deficiency is corrected in the generalized impulse approximation. The detailed behavior of the d_{13} wave in the vicinity of the second resonance is compared with recent fits to the experimental data and agreement is found for the resonance energy within 10 MeV. It is indicated that the unitary impulse approximation affords a simple alternative to dispersion-theoretic treatments of this problem. (Disser. Abstr.)

42322 ELECTROMAGNETIC WAVE THEORY, PART I. Proceedings of a Symposium held at Delft, The Netherlands, September 6–11, 1965. Brown, J. (ed.). International Series of Monographs in Electromagnetic Waves, Volume 11. New York, Pergamon Press, 1967. 556p. $21.50. (CONF-650990-(Pt.1)).

Sixty-one papers are presented grouped under the following main headings: wave propagation, waveguides, and overmoded and beam waveguides (surface waves). (B.G.D.)

42323 ELECTROMAGNETIC WAVE THEORY, PART II. Proceedings of a Symposium held at Delft, The Netherlands, September 6–11, 1965. Brown, J. (ed.). International Series of Monographs in Electromagnetic Waves, Volume 11. New York, Pergamon Press, 1967. 561p. $21.50. (CONF-650990-(Pt.2)).

Sixty-eight papers are presented, grouped under the following main headings: propagation in nonlinear media, antennas, scattering and diffraction, and statistical optics and coherence. (B.G.D.)

Weak

42324 (ITEF-491) RADIATSIONNYI ZAKHVAT μ^- MEZONOV I TOKI VTOROGO RODA. (Radiative μ^- Capture and Second Class Currents). Lobov, G. A.; Goreslavskii, S. P.; Lomonosova, T. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1967. 32p. (In Russian). Dep.

The dependence of various effects in the process of radiative capture of muons by free protons and in hydrogen on the weak interaction renormalization constants is considered. In the total probabilities of muon radiative capture, in photon spectra and in their circular polarization, the terms are taken into account with the order of magnitude $(m_\mu/m)^2$ (m_μ, m^- are the masses of muon and nucleon). The strong dependence of considered capture characteristics on the weak interaction renormalization constants can be used to establish the type of muon-nucleon interaction. (auth)

42325 (ITEF-492) T-NECHETNAYA KORRELYATSIYA V K^0_{l3} RASPADE I ELEKTROMAGNITNYI FORM FAKTOR π MEZONA. (T-Odd Correlation in the K^0_{l3} Decay and Electromagnetic Form Factor of the π Meson). Okun', L. B.; Khiplovich, I. B. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1967. 15p. (In Russian). Dep.

Muon polarization in the K^0 decay normal to the plane of decay is computed, this polarization being due to the electromagnetic interaction between the muon and the pion. The calculation takes into account the electromagnetic form factor of the pion as well as the form factors of the weak vertex. The contribution of the electromagnetic form factor may reach 10 to 15%, and the effect can be used for experimental determination of the electric radius of π-meson if the existing accuracy of experiment will be raised

by two orders of magnitude. The sign of correlation is the same for the $K^0 \to \pi\mu^+\nu$ and $\bar{K}^0 \to \pi^+\mu^-\nu$ decays. An analogous polarization due to the CP-violation will have different signs for these decays. The expression, the form factors being omitted, differs by the factor –2 from the corresponding previous results. (auth)

42326 SPECTRAL-FUNCTION SUM RULES AND K_{l3} FORM FACTORS. Biswas, S. N.; Smith, J. (Univ. of Adelaide). Nuovo Cim. (10), 51A: 214-16(Sept. 1, 1967).

Expressions for the weak form factors associated with K_{l3} decay are obtained. Using PCAC and taking the soft-pion limit one obtained a relation between f_K and the $K_{\mu 2}$ decay constant, and f_+, f_-, the usual K_{l3} decay form factors. It is noted that if the soft-kaon limit is used then it is possible to obtain an expression for the difference of f_+ and f_- in terms of the spectral functions of the vector and axial current propagators. This immediately leads to the determination of the ξ-parameter ($\xi = f_-/f_+$) and a value for $f_+(0)$. (J.F.P.)

42327 LEPTONIC DECAYS OF THE KAON ACCORDING TO CURRENT ALGEBRA AND PCAC. Oakes, R. J. (CERN, Geneva). Acta Phys. Austr., Suppl. 4, 309-19(1967).

From 6th International Proceedings on Special Problems in High Energy Physics, Schladming, Austria, Feb. 26–Mar. 9, 1965. See CONF-670216.

Recent calculations of the leptonic decays of the mesons (K) based on the current commutation relations of Gell–Mann and the assumption of PCAC are discussed. This is for the most part a review of previous work, although some new results are also discussed. (J.F.P.)

42328 ASYMPTOTIC CHIRAL SYMMETRY, SUPERCONVERGENCE, AND THE K_1^0–K_2^0 MASS DIFFERENCE. Biswas, S. N.; Smith, J. (Univ. of Adelaide). Phys. Rev. Lett., 19: 727-30 (Sept. 18, 1967).

The $K_1^0 - K_2^0$ mass difference is calculated within the framework of (a) the current-current picture for the weak Hamiltonian, (b) the current commutation relations of Gell-Mann, (c) the hypothesis of partially conserved axial-vector current for the K-meson field, and (d) the superconvergence sum rules obtained by Weinberg for the spectral functions of the vector and axial-vector current propagators in the content of SU(3) × SU(3) chiral symmetry. The assumption of approximating the vacuum expectation values of the time-ordered product of four vector and axial currents as products of vector and axial propagators is added. A reasonable agreement with experiment was obtained. (L.B.S.)

42329 WEAK INTERACTIONS AND NUCLEAR μ CAPTURE. Balashov, V. V.; Eramzhyan, R. A. pp 6-108 of Letnyaya Shkola Po Problemam Teorii Elementarnykh Chastits, Kyayariku 1965. Chistits I. Palgi, L.; Yiglane, Kh. (eds.). Tartu, Institute of Physics and Astronomy, Academy of Sciences, Estonian SSR, 1966 (In Russian).

The basic assumptions of the theory of weak interactions are reviewed and the effective Hamiltonian of μ capture is given. The μ-meson processes are reviewed and the formal theory of μ capture is described. The basic trends in the experimental study of μ capture are discussed and illustrated. (J.S.R.)

42330 CURRENT ALGEBRA AND PION ENERGY SPECTRUM IN $K \to 3\pi$ DECAYS. Gupta, K. C.; Majumdar, Rabi; Tripathy, K. C. (Univ. of Delhi). Phys. Rev., 160: 1275-7(Aug. 25, 1967).

Using the Weinberg technique, two pions (other than the odd pion) are simultaneously reduced in $K \to 3\pi$ decay modes. Then the current algebra and the hypothesis of partially conserved axial-vector current enable us to predict correctly the energy spectrum of the odd pion in these decays. (auth)

42331 DECAY WIDTHS OF THE ϕ MESON FROM ALGEBRA OF CURRENTS. Akiba, Tomoya; Kang, Kyungsik (Brown Univ., Providence). Phys. Rev., 160: 1283-5(Aug. 25, 1967). (NYO-2262TA-150).

The decay width of the ϕ meson is considered by using the hypothesis of a partially conserved axial-vector current and the equal-time commutation relations of the chiral SU(3) SU(3) current algebra. $\Gamma(\phi \to KK) = 3.9$ MeV is obtained to be compared with the latest experimental value $\Gamma^{exp}(\phi \to KK) = 4.0 \pm 1.0$ MeV. A comparison with the results of the SU(3) symmetry is made, and the electromagnetic decay modes of the ϕ are also discussed. (auth)

42332 RADIATIVE DECAYS OF HADRONS AND CURRENT CONSERVATION. Pestieau, J. (Univ., Louvain, Belg.). Phys. Rev., 160: 1555-9(Aug. 25, 1967).

Using electric current conservation, it is shown that in the series expansion of the amplitudes of radiative decays (with two particles at most in the final state, apart from the photon) in powers of the photon four-momentum, terms of order zero vanish unless they belong to photon pole diagrams. (auth)

42333 POSSIBLE $|\Delta T| = 3/2$ AMPLITUDES IN Λ^0 DECAY. Pondrom, Lee G. (Univ. of Wisconsin, Madison). Contract AT(11-1)-881. Phys. Rev., 160: 1374-5(Aug. 25, 1967). (COO-881-102).

Using $K_2^0 \to \pi\pi$ and $K^+ \to \pi\pi$ as a guide, estimates are made on the magnitudes of $|\Delta T| = 3/2$ amplitudes and possible CP violation in the decay $\Lambda^0 \to n\pi^0$. It is found that, consistent with current experimental data on Λ^0 decay, a small $|\Delta T| = 3/2$ amplitude could be reflected in an observable departure of α_0/α_- from unity, and that large CP-violating phases could be present. (auth)

42334 ZERO-ENERGY LIMITS AND NONLEPTONIC K DECAYS. Clavelli, L. J. (Univ. of Chicago). Phys. Rev., 160: 1384-94(Aug. 25, 1967). (COO-264-357).

A dynamical model is proposed that reproduces all the zero-energy limits predicted by the algebra of currents for the $K_{2\pi}$ and $K_{3\pi}$ amplitudes. The nonlinearities predicted by the algebra as two pions are brought to zero four-momentum in different order are related to a gauge condition on the weak interactions of vector mesons. Over-all numerical agreement is good including prediction of the $K^+ \to \pi^+\pi^0$ rate and other violations of the $\Delta T = 1/2$ rule. Mass-shell corrections to the current-algebra relations between $K_{3\pi}$ and $K_{2\pi}$ are given by the model in good agreement with experiment. (auth)

Strong (General)

42335 (IAE-1285) K VOPROSU O VOZMOZHNOSTI EKSPERIMENTAL'NOGO OBNARUZHENIYA TEPLOVYKH KVARKOV. (Possibility of Experimental Detection of Thermal Quarks). Kucheryaev, Yu. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). 1967. 53p. (In Russian). Dep.

The quark model assumes the existence of three particles (p, n and λ-quarks) with electric charges respectively of $+2/3$, $-1/3$ and $-1/3$ of an elementary electric charge. The quark mass is unknown but should be >7 GeV. Estimates of the concentration of thermal quarks lead to values of 10^{-9} to 10^{-19} quarks per nucleon. Methods of searching for thermal quarks include a mass-spectrometric method and Milliken's oil drop method where the charge is measured directly. Another possible method of detecting thermal quarks, which is discussed in detail involves the collection of quarkions on a metal surface. Since the charge of a quarkion is less than one, its binding energy with the metal surface can be significantly less than the binding energy of an ordinary, single-charged ion. Since the time of accumulation of quark ions on the electrode surface can be many orders of magnitude greater than the time of desorption, the method is inherently more sensitive than the other methods. All the discussions consider only quarkions with a charge of $-1/3$. A possible experimental arrangement for detecting quarkions is given. (TTT)

42336 ZEROS IN THE REGGE FORMULA. Chew, Geoffrey F. Comments Nucl. Particle Phys., 1: 58-62(Mar. 1967).

A survey of the elements recognized for zeros in the Regge formula is given. This survey includes the Toller analysis, which greatly clarifies the issues surrounding the zeros of the Regge formula at t = 0. (J.F.P.)

42337 HIGH ENERGY SCATTERING OF HADRONS. Kokkedee, J. J. J. (CERN, Geneva). Acta Phys. Austr., Suppl. 4, 145-86(1967).

From 6th International Proceedings on Special Problems in High Energy Physics, Schladming, Austria, Feb. 26–Mar. 9, 1965. See CONF-670216.

Some recent developments in the theory of elastic scattering of hadrons at high energy and small momentum transfers are discussed. The energy region above the laboratory momentum of 4 GeV/c is considered. Two recently proposed models for predicting relations between the various meson–baryon and baryon–baryon cross sections at high energies, namely, the quark model and the combination of Regge pole model and current algebra are considered. A few general asymptotic properties of elastic scattering amplitudes are also briefly mentioned. (J.F.P.)

42338 VECTOR MESONS AND THE ELECTROMAGNETIC INTERACTIONS OF HADRONS. Joos, H. (DESY, Hamburg). Acta Phys. Austr., Suppl. 4, 320-59(1967).

From 6th International Proceedings on Special Problems in High Energy Physics, Schladming, Austria, Feb. 26–Mar. 9, 1965. See CONF-670216.

The improved understanding of the electromagnetic interaction of hadrons due to data on photon and electron interactions with hadrons in the multi-GeV-region from electron accelerators is discussed. The procedure is to consider several experimental results under the uniform aspect of a single model, the vector

meson dominance model of the electromagnetic interaction of hadrons. A general viewpoint is given. (J.F.P.)

42339 THE POMERANCHUK TRAJECTORY: ACTUALITY OR MIRAGE? Chew, G. F. (Univ. of California, Berkeley). Comments Nucl. Particle Phys., 1: 121-4(July-Aug. 1967).

The relation of the special properties of the vacuum quantum numbers to the Pomeranchuk trajectory is reviewed. The status of the Pomeranchuk trajectory is found to remain obscure. (J.F.P.)

42340 QUARK MODEL AND RADIATIVE TRANSITIONS. Renard, F. M. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nucl. Phys., B2: 537-64(1967).

Radiative transitions of mesonic and baryonic states are studied carefully in the nonrelativistic quark model. The complete formulas for electric and magnetic multipoles are written. General selection rules specific of the quark structure are then obtained: additional ones follow from the symmetrization properties of the three-quark baryonic states. Invariance properties of the space wave functions leading to relations between the multipole amplitudes are proposed. Applications are given for the 0^-, 1^-, 2^+, 1^+, 1^{2+}, 0^+ mesons and for $\frac{1}{2}^-$, $\frac{3}{2}^+$, $\frac{1}{2}^-$, $\frac{3}{2}^-$, $\frac{5}{2}^-$ baryons. (auth)

42341 COVARIANCE OF THE RETARDED PRODUCT OF AXIAL-VECTOR CURRENTS AND THE FORM OF THEIR EQUAL-TIME COMMUTATOR. Dietz, Klaus; Kupsch, Joachim (Univ., Bonn). Nucl. Phys., B2: 581-96(1967).

The conditions for covariance of the truncated retarded products of two axial-vector currents and of one axial-vector and its divergence are established. The form of the equal-time commutator (truncated) of an axial-vector current and its time component proposed by Gell-Mann follows up to a scaling factor from these covariance conditions, whereas the form of the quark-model commutator for space-space components does not result. For theories in which these conditions do not hold, a covariant off-shell amplitude (there is no problem of covariance for on-shell amplitudes) is constructed. Useful sum rules do not seem to follow in this case. One of the reasons for this is that the dispersion approach of Fubini, Furlan and Rossetti has to be modified. Furthermore, another version of Adler's consistency condition is derived. (auth)

42342 QUARKS AND MAGNETIC POLES. Schiff, L. I. (Stanford Univ., Calif.). Contract AF49(638)-1389. Phys. Rev., 160: 1257-62(Aug. 25, 1967).

A theory is developed which accounts for the free nonrelativistic motion of fractionally charged quarks within hadrons, and at the same time does not permit quarks to appear as individuals. This is accomplished by modifying Dirac's idea that the quantization of electric charge derives from the existence of a point magnetic pole, to include the situation in which the pole is extended in space and of hadronic size. The needed formalism makes use of Mandelstam's gauge-independent, path-dependent quantum electrodynamics, as extended by Cabibbo and Ferrari to include the existence of point magnetic poles. It is shown that the further extension to a pole of finite size and the use of parallel straight paths are the only new features that are required. In particular, no assumptions need be made with regard to the masses of quarks, the interactions between them, or the existence of a constraining potential. (auth)

Strong (Baryon No. = 0)

42343 SOME REMARKS ON FORWARD $\rho\pi$ SCATTERING SUM RULES. D'Auria, R.; Napolitano, E.; Soliani, G. (Univ., Turin). Nuovo Cim. (10), 51A: 239-43(Sept. 1, 1967).

The problem of the saturation of $\rho\pi$ scattering sum rules is discussed. It is concluded that saturation of a set of sum rules has not yet a well-defined treatment. But it is believed that even though a general set of sum rules cannot be used for precise theoretical predictions about the quantities involved, they can always be used as an indicative test for experimental results. (J.F.P.)

42344 SATURATION OF SUPERCONVERGENT SUM RULES AT NONZERO MOMENTUM TRANSFER. Ademollo, M. (Univ., Florence); Rubinstein, H. R.; Veneziano, G.; Virasoro, M. A. Nuovo Cim. (10), 51A: 227-31(Sept. 1, 1967).

The point of view that the nonresonant high-energy contribution is in general important and may be even crucial for the t-dependence of the sum rule is presented. It is supposed that this contribution can be described in terms of a few Regge trajectories. As a first test of the assumptions the superconvergent sum rules for pseudoscalar–vector meson scattering are considered. These are saturated by the experimentally known low-lying resonances and Regge trajectories. The interactions $\pi + \rho \to \pi + \rho$, $\pi + K^* \to \pi + K^*$, and $K + \rho \to K + \rho$ are discussed. (J.F.P.)

42345 AXIAL-VECTOR MESONS AND CURRENT ALGEBRA. Costa, G. (Rutherford High Energy Lab., Chilton, Eng.); Savoy, C. A.; Zimerman, A. H. Nuovo Cim. (10), 51A: 201-4(Sept. 1, 1967).

The implication of the mass relation $m_A = \sqrt{2}m_\rho$ which follows from two previously derived sum rules relating spectral functions of vector and axial-vector currents, are discussed in the derivation of corresponding relation for the s-wave $A_1 \to \rho + \pi$ decay constant. This derivation is based on the algebra of vector and axial-vector currents, PCAC, and the universality of the meson (ρ) coupling to the isovector current. (J.F.P.)

42346 WHY IS $1 - 2F_\pi^2\gamma^2_{\rho\pi\pi}m_\rho^2 \cong 0$? Geffen, D. A. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev. Lett., 19: 770-3(Sept. 25, 1967).

It is pointed out that the relation between the $\rho\pi\pi$ coupling constant and ρ mass and F_π, the fundamental constant of PCAC, $1 - 2F_\pi^2\gamma^2_{\rho\pi\pi}/m_\rho^2 \cong 0$ does not follow from PCAC, ρ dominance, and current algebra as unambiguously as was previously thought. In particular, a generalization of this relation which indicates that its approximate validity is related to the relative weakness of the interaction in the $\rho\pi$ system with the quantum numbers of the meson (A_1), $I(J^{PC}) = 1(1^+)$. (J.F.P.)

42347 IMPLICATIONS OF THE DOUBLE-POLE CHARACTER OF THE A_2 MESON. Lassila, K. E.; Ruuskanen, P. V. (Ames Lab., Iowa). Phys. Rev. Lett., 19: 762-5(Sept. 25, 1967). (IS–1630).

The observed double-pole characteristics of the $A_2^-(1300)$ are explained by a nondiagonalizable degenerate mass matrix for two mesons one of which decays predominantly into $\pi + \rho$. The presence of the other, possibly already observed meson would cause the A_2 characteristics to change considerably from one production process to another. From available limited statistics experiments this appears likely. (auth)

42348 ON THE FORWARD DISPERSION RELATION OF THE AMPLITUDE $\pi^+\pi^0 \to \pi^+\pi^0$. Antoniou, N. G. (Univ. of Birmingham, Eng.). Nucl. Phys., B2: 648-56(1967).

The effect of the high-energy singularities on the low-energy π-π scattering is investigated. In a specific model for the process $\pi^+\pi^0 \to \pi^+\pi^0$ based on forward dispersion relations, proposed by Shirkov, the high-energy limit of the total cross section, and the scattering length of the T = 2S-wave interaction are determined by assuming that the ρ-resonance dominates the amplitude in the appropriate energy region. The acceptable solution of the model suggests a low-energy repulsion in the T = 2 channel and a value of the scattering length in the region $-0.7\ m_\pi^{-1} < a_0^{(2)} < -0.5\ m_\pi^{-1}$. The Pomeranchuk limit of the total cross section is found to be $12\ \text{mb} < \sigma_\infty < 20\ \text{mb}$ in agreement with previous predictions based on various phenomenological models. (auth)

42349 DISPERSION RELATIONS FOR FORWARD PION–PION SCATTERING AND THEIR CONSISTENCY WITH WOLF PION–PION PHASE SHIFTS. Pisut, J. (Komenskeho Univ., Bratislava). Czech. J. Phys., 17: 489-99(1967).

It is shown that the Wolf pion-pion phase shifts are in reasonable agreement with dispersion relations for forward scattering. The extent to which the inaccuracies of the experimental data might modify this agreement is examined. An attempt is made to explain some discrepancies which arise probably from too broad a ρ-meson peak. (auth)

42350 MODEL FOR $p\bar{p}$ ANNIHILATION IN FLIGHT WITH MULTIPION PRODUCTION. Berzi, Vittorio (Univ., Milan); Istituto Nazionale di Fisica Nucleare, Milan); Recami, Erasmo. Phys. Rev., 160: 1263-71(Aug. 25, 1967).

A "nucleon-exchange" model for $p\bar{p}$ annihilation in flight into pions is considered. The aim of the model is to explain the observation that, in the c.m. system, charged mesons seem to prefer the direction of the nucleon of equal charge. As suggested by Minami, it is assumed that a virtual annihilation with multipion production (treated in the spirit of the statistical model) is preceded by a peripheral emission of one pion by both nucleon and antinucleon. The conditions that Lorentz and isospin invariances impose on the structure both of the contributions of the peripheral-emission vertices, and of the virtual-annihilation amplitude are taken into account. A final formula for the π^+ (or π^-) angular distribution is given. With the help of some physical simplifying considerations, this formula is reduced to a numerically evaluable one (by using some phase-space techniques), and the results are compared with the available experimental data at the entering laboratory momenta of 1.6 GeV/c, 3.3 GeV/c, and 5.7 GeV/c. Despite the fact that the model neglects resonance production, a satisfactory enough accord has been found. (auth)

42351 OBSERVABLE EFFECTS OF THE LEADING LANDAU SINGULARITY OF THE BOX GRAPH. Collas, Peter; Norton,

Richard E. (Univ. of California, Los Angeles). Phys. Rev., 160: 1346-58(Aug. 25, 1967).

The effect of the leading Landau singularity of the fourth-order single-loop graph in a two-particle to four-particle amplitude is investigated. The amplitude for the graph is evaluated from a dispersion relation in the mass squared of the two particles interacting in the final state, and its behavior is studied using a simple model. The reactions $\bar{p}p \to \bar{K}K\pi\pi$ and $\bar{p}p \to \bar{\Lambda}\Lambda\pi^+\pi^-$ are examined in some detail, and peaks are predicted for the amplitude squared in a certain range of the external variables. (auth)

42352 ASYMPTOTIC BEHAVIOR OF FORM FACTORS. Nath, Pran; Srivastava, Y. N. (Northeastern Univ., Boston). Phys. Rev., 160: 1406-10(Aug. 25, 1967).

The asymptotic behavior of form factors is examined in the presence of inelastic states. It is shown how the form factors can vanish asymptotically when the density of inelastic states assumes a sufficiently rapid power behavior in energy. Three distinct, soluble models for scattering are examined, and the relationship among the asymptotic behavior of form factors, inelasticities, and diffraction scattering amplitudes are discussed. It is pointed out that the scattering amplitudes need not approach their Born amplitudes asymptotically when the density of inelastic states increases sufficiently rapidly with energy. (auth)

42353 $p + \bar{p} \to n + \bar{n}$ CHARGE-EXCHANGE SCATTERING. Dita, Petre (Inst. of Physics, Bucharest); Nicolescu, Basarab. Phys. Rev., 160: 1395-6(Aug. 25, 1967).

The charge-exchange reaction $p + \bar{p} \to n + \bar{n}$ is studied, and a single-Regge-pole-model formula, in good agreement with experimental data is given. The main assumption is that the Regge trajectory at $\alpha \to 0$ has a "nonsense" value. The ρ trajectory cannot fit the experimental data. A linear leading trajectory of negative signature was chosen, and it was found that such a trajectory, with the intercept $\alpha(0) = 0.17$ and the slope $\alpha^1(0) = 0.07$, can satisfactorily explain the process considered. (auth)

42354 ESTIMATE OF THE π-π TOTAL CROSS SECTION AND DIFFRACTION WIDTH. Abbe, W. J. (Univ. of Michigan, Ann Arbor). Phys. Rev., 160: 1519-21(Aug. 25, 1967).

The total π-π cross section and diffraction width at high energy were estimated via a simple approximation procedure for the reduced residue which was recently noted in potential theory. Results consistent with the present known facts on the π-π system are obtained, and it is concluded that this approximation procedure may provide a simple and yet accurate means of estimating total high-energy cross sections and diffraction widths once the crossed-channel trajectories are known. (auth)

Strong (Baryon No. = 1)

42355 (ITEF-487) OB ODNOI VOZMOZHNOSTI OBNARUZHENIYA VETVLENII SVYAZANNYKH S p I p' POLYUSAMI. (On a Possibility of Finding Out the Branch Points Connected with p and p' Poles). Levintov, I. I. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1967. 8p. (In Russian). Dep.

If the π^+-ρ scattering asymptotics is determined by two isolated poles with the positive signature (p and p') and by any number of poles with the negative signature, the following relation can be obtained.

$$\lg\left[\left(\rho\frac{\alpha\sigma}{\alpha t}\right)_- + \left(\rho\frac{\alpha\sigma}{\alpha t}\right)_+ + \left(\rho\frac{\alpha\sigma}{\alpha t}\right)_{ex}\right] = \lg F(t) - [2 - \alpha\rho(t) - \alpha\rho'(t)]\lg E$$

where $[\rho(\alpha\sigma/\alpha t)]_i$ is the product between the polarization and the differential cross section for π^i-ρ elastic scattering, $[\rho(\alpha\sigma/\alpha t)]$ is the same product in charge exchange case, $\alpha\rho\rho'(t)$ is the trajectory of p,p' poles, F(t) is a function of the residues in p,p' poles, E is the energy (BeV). Thus the violation, experimentally discovered, of a lg E linear dependence of the left side of the above-written relation would mean either the necessity of introducing additional poles with the positive signature (which would cause certain difficulties) or E dependent F(t) connected with the branch points in p and p'. (auth)

42356 (UCRL-17671) AN ANALYTICAL AND NUMERICAL STUDY OF THE BOUND-STATE SOLUTIONS TO THE PION-NUCLEON BETHE-SALPETER EQUATION. Rothe, Klaus D. (California Univ., Berkeley. Lawrence Radiation Lab.). July 24, 1967. Contract W-7405-eng-48. 151p. Dep. CFSTI.

Thesis.

The Bethe-Salpeter equation describing the interaction of pseudoscalar mesons and nucleons via pseudoscalar coupling is solved numerically for energies below the elastic threshold by use of variational techniques. Only the "ladder" approximation with a local potential corresponding to the exchange of an elementary nucleon is considered. Simple generalizations of this form of the interaction are considered as well. In the absence of a cutoff this leads to a marginally singular integral equation. The boundary conditions to be imposed on the solutions are examined in detail in order to lead to a discrete eigenvalue spectrum. The study of this problem is considerably simplified at zero total cm energy, where the (Wick rotated) equation is invariant under four-dimensional rotations. In order to take full advantage of this symmetry, a new set of spinor spherical harmonics belonging to the representations $[(n \pm 1/2), (n/2)]$ and $[(n/2, (n \pm 1/2)]$ of the four-dimensional rotation group are constructed. The discussion is then extended to the general case, in which the formal structure of the $E \neq 0$ solutions is examined briefly. Attention is given to the role of the "relative time" in a relativistic theory, and the closely related problem of arriving at a time-independent approximation of the BS equation. In particular, the static and nonrelativistic limit of the equation is considered, and the validity of the approximations involved is discussed. The eigenvalue spectrum obtained in the two limits is compared to that of the original equation. Finally, a brief discussion is given of the Nθ and Vθ sectors of the Lee model, designed to illustrate still further the observations on the role of the "relative time" in a relativistic theory. (auth)

42357 CONCERNING ONE POSSIBILITY OF OBSERVING BRANCH POINTS CONNECTED WITH p AND p' POLES. Levintov, I. I. JETP Lett. (USSR)(Engl. Transl.), 5: 367-9 (June 15, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 5: 454-6(June 15, 1967).

A method of observing the effects of branch points connected with p and p' poles is indicated. Elastic $\pi^+ + p$ and $\pi^- + p$ and charge exchange interactions are considered. (J.F.P.)

42358 WAVE FUNCTIONS OF BARYONS AND FUNDAMENTALS OF QUARK DYNAMICS. Leontovskii, M. P. (Moscow Polygraphic Inst.). JETP Lett. (USSR)(Engl. Transl.), 5: 362-5(June 15, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 5: 448-51(June 15, 1967).

It is shown that the parity of a three-particle system (without internal parity) is $P = (-1)^L$, where k is the projection of L on the running perpendicular to the particle plane, and that there are no kinematic grounds for $P = (-1)^L$. The general form of the wave functions when the spatial part is separated, and an example when this is not done are given. (J.F.P.)

42359 PREDICTION OF POLARIZATION OF $K^-p \to \bar{K}^0n$ AT HIGH ENERGIES. Reeder, D. D.; Sarma, K. V. L. (Univ. of Wisconsin, Madison). Contract AT(11-1)-881. Nuovo Cim. (10), 51A: 169-74(Sept. 1, 1967). (COO-881-106).

A Regge-pole model is constructed to fit the high-energy data on the reactions $\pi^-p \to \pi^0n$, $\pi^-p \to \eta n$, and $K^-p \to \bar{K}^0n$ for the momentum transfer region $-2.5 \lesssim t \lesssim 0$ (GeV/c)^2. The model predicts a large polarization in $K^-p \to \bar{K}^0n$ independent of the momentum ($5 \lesssim p_{K^-} \lesssim 12$ GeV/c) near the forward direction and a second minimum at $t = -2.5$ (GeV/c)^2 in $\pi^-p \to \pi^0n$. (auth)

42360 PION-NUCLEON COLLISION AND SINGLE-PION PRODUCTION. II. Gleeson, A. M. (Syracuse Univ., N. Y. Univ. of Pennsylvania, Philadelphia); Mahanthappa, K. T. Nuovo Cim. (10), 51A: 40-73(Sept. 1, 1967).

A model which is used to calculate both the elastic and production channel is formulated. This model is designed to be completely solvable, yet to include all the effects of the physical process. The model is basically a pole model which includes the anomalous thresholds. The model predicts the existence of the $N^*_{33}(1236)$, $N^*_{11}(1518)$, and $N^*_{11}(1688)$. No other resonance effects are found in the elastic channel. The cross-sections and angular distributions of the production channels are given. (auth)

42361 VECTOR DOMINANCE SUM RULES AND THEIR DYNAMICAL CONTENT. Beg, M. A. B. (Argonne National Lab., Ill.). Phys. Rev. Lett., 19: 767-70(Sept. 25, 1967).

Sum rules for meson-baryon scattering, emerging from the hypothesis of threshold vector dominance, are discussed. It is shown that these sum rules provide a dynamical basis for SU(6)-like results, and shed some light on "partial symmetry." (auth)

42362 DISPERSION SUM RULES IN ELEMENTARY PARTICLE PHYSICS. de Alfaro, V. (Univ., Torino, Italy). Acta Phys. Austr., Suppl. 4, 39-97(1967).

From 6th International Proceedings on Special Problems in High Energy Physics, Schladming, Austria, Feb. 26-Mar. 9, 1965. See CONF-670216.

A short account is given of the status of the strong interaction sum rules. Also given are some observations about the analogous sum rules arising in current algebra. Asymptotic behavior of

scattering amplitudes for large energy and fixed momentum transfer, invariants, applications of superconvergence sum rules, saturation of superconvergence sum rules, and current algebra are discussed. (J.F.P.)

42363 GENERAL CLASSIFICATION OF CONSPIRACY RELATIONS. Hogaasen, H.; Salin, Ph. (CERN, Geneva). Nucl. Phys., B2: 657-68(1967).

A study of constraints on helicity amplitudes when the external particles have arbitrary spins is presented. The reaction $\pi N \rightarrow \rho N$ is studied in detail and two types of "conspiracy relations" are found. The first one occurs at t = 0 when the masses of π and ρ are different; it is different from the Gribov-Volkov type as it vanishes when the masses of π and ρ are equal. The Gribov-Volkov type of relations is very different from the preceding one and occurs when the masses of π and ρ are the same. It is shown how all these relations can be found without explicit reference to the invariant amplitudes and argued that generally all conspiracy relations can be obtained directly from the Trueman-Wick crossing relations between helicity amplitudes. (auth)

42364 MASS FORMULAS AND THE ALGEBRAIC STRUCTURE OF SUPERCONVERGENCE RELATIONS. Gilman, Frederick J. (California Inst. of Tech., Pasadena); Harari, Haim. Contract AT(11-1)-68. Phys. Rev. Lett., 19: 723-6(Sept. 18, 1967).

Sets of t = 0 current-algebra and superconvergence sum rules are treated as equations in the coupling constants and masses of states which are assumed to dominate the sum rules. The solutions of these sets lead to new mass relations among particles of different spins and parities. The algebraic structure of the sum rules and their solutions is discussed. (auth)

42365 THE EXCITED STATES OF PROTON. Wilson, R. (Harvard Univ., Cambridge, Mass.). Comments Nucl. Particle Phys., 1: 128-31(July-Aug. 1967).

The results of research on nucleon resonances are reviewed, and these resonances are listed according to trajectories. The discussion begins with the discovery of the first nucleon resonance in 1951 and includes symmetry and quark models. (J.F.P.)

42366 THE $K_1^0K_1^0$-MASS SPECTRUM. Fischer, W. E. (Eidgenossische Technische Hochschule, Zurich). Helv. Phys. Acta, 40: 749-77(Oct. 1, 1967). (In German).

A phenomenological interpretation of the $K_1^0K_1^0$-mass-spectrum is presented. The decay-distributions of resonances are compared with the predictions of the absorption model. Suitable interference terms are introduced to interpret the experimental results. The resonances are also discussed in the framework of SU_3 and the quark model. (auth)

42367 RELATIVISTIC TREATMENT OF STRUCTURE IN THE COULOMB INTERFERENCE PROBLEM. Locher, M. P. (CERN, Geneva). Nucl. Phys., B2: 525-31(1967).

The effect of form factors on the Coulomb phase angle in elastic high-energy scattering of charged particles is discussed. The influence of the angular dependence of the strong interaction part on the phase is included. Essentially the nonrelativistic result of Bethe turns out to be correct. (auth)

42368 CROSS-SECTION SUM RULES IN THE STATIC MODEL. Noga, M. (Comenius Univ., Bratislava). Nucl. Phys., B2: 532-6(1967).

On the basis of the unitary sum rules and of the self-consistency condition for the coupling constant ratios of the static model, the cross section sum rules are reduced to the eigenvector problem. It is shown that the meson-baryon scattering is allowed only in those partial waves in which there is a bound state or a resonance. The pion-nucleon scattering is considered in some detail, and the results obtained for it are compared with experiment. (auth)

42369 MESON-BARYON SCATTERING IN A QUARK MODEL. Deloff, A. (Rutherford High Energy Lab., Chilton, Eng.). Nucl. Phys., B2: 597-607(1967).

High-energy meson-nucleon scattering in a quark model is considered. Only nucleons are assumed to have quark structure, the quark structure of mesons is conjectured to be less important. The total and differential cross sections for all measurable elastic meson-nucleon scattering are calculated in eikonal approximation which takes into account single and double collisions with quarks inside a nucleon. With SU(3) all data are expressed in terms of four free parameters which are fitted from the total cross sections. The obtained results agree with experiment to within 10%. (auth)

42370 POLARIZATION AT FORWARD ANGLES AND SCATTERING AMPLITUDES IN $\pi-N$ ELASTIC SCATTERING. Yokosawa, A. (Argonne National Lab., Ill.). pp 127-32 of Polarized Targets and Ion Sources. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, [1967].

From Conference on Polarized Targets and Sources, Saclay, France, Dec. 5–9, 1966. See CONF-661205.

From polarization measurements on the π-N interaction at 2.5 GeV/c the nonflip and spinflip scattering amplitudes are evaluated from the phase-shift solution. The results are shown in terms of phase shifts and agree with those obtained by partial-wave analysis. The helicity nonflip, A_2, and helicity-flip, A_4, amplitudes are also evaluated using the phase-shift solution at 2.5 GeV/c. (W.H.K.)

42371 DEFINITION AND DETERMINATION OF SPIN AMPLITUDES. SOME APPLICATIONS OF POLARIZED TARGETS IN HIGH ENERGY PHYSICS. Jacob, M. (CEN, Saclay, France). pp 235-59 of Polarized Targets and Ion Sources. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, [1967].

From Conference on Polarized Targets and Sources, Saclay, France, Dec. 5–9, 1966. See CONF-661205.

A technical approach to the applications of polarized targets in high energy physics is presented. The definition and properties of spin amplitudes and details on the determination of the meson–baryon scattering amplitudes are given. (W.H.K.)

42372 SOME POLARIZED TARGET EXPERIMENTS FOR ELEMENTARY PARTICLE PHYSICS. Dalitz, R. H. (Oxford Univ.). pp 261-72 of Polarized Targets and Ion Sources. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, [1967].

From Conference on Polarized Targets and Sources, Saclay, France, Dec. 5–9, 1966. See CONF-661205.

The major areas of phenomena in elementary particle physics using polarized targets are presented. Experiments involving resonant states formed by direct collisions using polarized targets are discussed. Also, reaction processes in which the resonant state is observed as a final-state interaction among the particles resulting from a multiparticle production process are discussed. (W.H.K.)

42373 RADIATIVE μ CAPTURE. Lobov, G. A. pp 135-63 of Letnyaya Shkola Po Probleman Teorii Elementarnykh Chastits, Kyayariku 1965. Chastits I. Palgi, L.; Yiglane, Kh. (eds.). Tartu, Institute of Physics and Astronomy, Academy of Sciences, Estonian SSR, 1966. (In Russian).

The general questions of the theory of muon-nucleon interaction are reviewed. The experimental data on muon-nucleon interactions are given. The radiative capture of muons by free protons, in hydrogen, and by nuclei is described. Experimental data on the radiative capture of muons by nuclei are reviewed. (J.S.R.)

42374 QUARK MODEL AND HIGH ENERGY PRODUCTION PROCESSES. Satz, H. (Deutsches Elektronen-Synchrotron, Hamburg). Phys. Lett., 25B: 220-2(Aug. 21, 1967).

The additivity assumption for quark constituents in hadronic reactions is applied to high energy production processes. It is shown that this assumption together with a statistical model for quark-quark production reactions leads to a simple picture which successfully describes the essential aspects on nonannihilation production reactions. (auth)

42375 THE POSSIBLE EXISTENCE OF A $(\pi\rho)$ RESONANCE NEAR 1300 MeV WITH A SPIN-PARITY ASSIGNMENT OF 2^- OR 1^+. Morrison, D. R. O. (CERN, Geneva). Phys. Lett., 25B: 238-41(Aug. 21, 1967).

It is shown that most of the results on the analysis of the A_2 meson are consistent with the hypothesis that there exist two $(\pi\rho)$ resonances near 1300 MeV, both of isospin I = 1, but one with spin-parity $J^P = 2^+$ and the other with $J^P = 2^-$ or 1^+. An important new feature of the analysis is the consideration of the variation of cross section with incident momentum and in particular the effects of Pomeron exchange. (auth)

42376 NECESSITY OF PRODUCTION AMPLITUDES IN QUANTUM FIELD THEORY. Cheung, Franklin F. K.; Toll, John S. (State Univ. of New York, Stony Brook). Phys. Rev., 160: 1072-6(Aug. 25, 1967).

A nonvanishing production amplitude in the pion-nucleon scattering is proved to be a necessary consequence of relativistic invariance, causality, crossing, and unitarity relations in quantum field theory. (auth)

42377 SOLUTION OF THE STATIC-MODEL BETHE–SALPETER EQUATION FOR THE PION-NUCLEON PROBLEM. Bondyopadhyay, D.; Biswas, S. N.; Saxena, R. P. (Univ. of Delhi). Phys. Rev., 160: 1272-4(Aug. 25, 1967).

The Bethe-Salpeter equation is solved numerically for the static model of the pion-nucleon scattering below the first inelastic threshold. Using the Noyes technique, the equation is made singularity free and is shown to satisfy exactly the unitarity in the elastic region. The reciprocal-bootstrap problem of Chew involving N and N* was considered with the adjustable cutoff parameter. Further, the P_{11} and P_{31} pion-nucleon phase shifts were obtained

and compared with experiment. The agreement of the P_{11} as well as the P_{31} phase shifts below the first inelastic threshold with experiment is remarkably good in the present model. (auth)

42378 MODIFIED πN SUPERCONVERGENCE AND THE STATIC MODEL. Balazs, L. A. P.; Cornwall, John M. (Univ. of California, Los Angeles). Phys. Rev., 160: 1313-21(Aug. 25, 1967).

Recently, superconvergence relations have been proposed for certain scattering amplitudes with spin at fixed momentum transfer. Unfortunately, the kinematics and high-energy behavior of πN scattering do not permit any such relations for this process. If, however, one assumes Regge-pole dominance at high energy, one can write superconvergence relations for certain amplitudes from which the leading Regge-pole contributions have been subtracted out. Assuming resonance dominance in the low-energy region, one has a sum rule relating these resonances to the Regge parameters. Comparison with experimental data in the forward direction shows that the Regge contribution is small and that the dominant resonances are the N and N*; the sum rule is then approximately satisfied. Completely ignoring the Regge poles and making certain additional assumptions leads to a relativistic version of the static model, which gives a relation, for instance, between the N and N* coupling constants. This relation is quite well satisfied. In addition one may derive the Adler PCAC (partially conserved axial-vector current) self-consistency condition. These results are shown to be related to the vanishing of the equal-time commutator of the pion currents. (auth)

42379 FIXED-u SUM RULES IN πN SCATTERING. Beder, Douglas S.; Finkelstein, Jerome (Univ. of California, Berkeley). Phys. Rev., 160: 1363-5(Aug. 25. 1967).

It is observed that the πN invariant amplitudes A and B, at fixed $u = 0$ and $I_u = \frac{1}{2}$, give rise to sum rules of the type now becoming familiar from superconvergence relations, even though the amplitudes are not superconvergent. With the s-channel ($\pi N \rightarrow \pi N$) spectrum approximated by the nucleon and the $\Delta(1238)$, and the t-channel ($\pi\pi \rightarrow N\bar{N}$) spectrum approximated by the ρ, it is found that the sum rule obtained from the B amplitude is satisfied very well, while that from the A amplitude is not. It is speculated that this discrepancy might be due to the $\pi\pi$ s wave, which is rigorously absent from the B sum rule. (auth)

42380 SUPERCONVERGENT RELATIONS FOR THE PROCESS $\pi N \rightarrow \rho N$. Graham, R. H.; Huq, M. (Syracuse Univ., N. Y.). Phys. Rev., 160: 1421-6(Aug. 25, 1967). (NYO-3399-109).

The process $\pi N \rightarrow \rho N$ is considered. The high-energy behavior of the invariant amplitudes following from the exchange of Regge trajectories allows three consistent superconvergent sum rules to be written. Five other sum rules, obtained by equating to zero the coefficients of higher powers of t, lead to inconsistencies. In the degenerate-mass limit, partial consistency with the U(6,6) theory is obtained. (auth)

42381 HIGH-ENERGY CONSISTENCY CONDITIONS AND SUPERCONVERGENCE SUM RULES. Kugler, M. (Rockefeller Univ., New York). Phys. Rev., 160: 1574-82(Aug. 25, 1967).

High-energy consistency conditions in the form of superconvergence sum rules are presented for three cases: (1) combinations of partial-wave amplitudes in potential scattering; (2) a fixed-angle dispersion relation in relativistic theory; (3) partial-wave amplitudes in πN scattering. Resonance saturation of the last is attempted. In this approximation, one class of sum rules involving combinations of $f_1(w)$ agrees roughly with experiment; two of which are more sensitive to approximation disagree. (auth)

42382 TEST OF A SUM RULE FOR THE NUCLEON MAGNETIC MOMENTS. Hoehler, G.; Strauss, R. (Technische Hochschule, Karlsruhe, Ger.). Z. Phys., 204: 419-24(1967).

It is shown that the original version of the sum rule relating the isovector part of the nucleon magnetic moment to a πN scattering amplitude is not consistent with the experimental data. However there is good agreement for the corrected version of Maiani and Preparata. (auth)

42383 π-NUCLEON CHARGE EXCHANGE AND ρ POLE. Derem, A. (CEN. Saclay, France). J. Phys. (Paris), 28: 377-82 (May-June 1967). (In French).

The single Regge pole model (ρ-exchange in the t-channel) successfully explains the differential cross sections for the reaction $\pi^- + p \rightarrow \pi^0 + n$ at high energy. An attempt is made to determine accurately the $\alpha_\rho(t)$ trajectory and the pole residues of the scattering amplitudes involved. (auth)

Strong (Baryon No. ≥ 2)

42384 EXPERIMENTAL TESTING OF THE ANALYTICITY STRUCTURE OF THE S-MATRIX. Arndt, R. A.; Moravcsik, M. J. (Univ. of California, Livermore). Nuovo Cim. (10), 51A: 108-17(Sept. 1, 1967).

A tentative experimental test of the analyticity structure of the S-matrix in low-energy nucleon-nucleon scattering is performed by showing that among an appreciable number of functions describing the energy dependence of phase shifts in proton-proton scattering dynamics, satisfying various threshold and asymptotic requirements, those having qualitatively the proper analytic structure give somewhat better fits to experimental data than those with "improper" analytic structure. Statements are also made about the relative merits of various approximation schemes. (auth)

42385 ANGULAR MOMENTUM DEPENDENT POTENTIALS IN NUCLEON-NUCLEON SCATTERING. Cronstrom, C. Kgl. Danske Vidensk. Selsk., Det, Mat.-Fys. Medd., 35: 1-23(1967).

We investigate the general properties of the most general local, angular momentum dependent nucleon-nucleon potential. We generalize the arguments of a previous paper on angular momentum dependent potentials, to take into account the complications which arise because of the spin of the nucleons. As an example we consider a scalar boson exchange potential, and show that the conventional approximation methods for obtaining local potentials from field theory are completely misleading in this case. (auth) (DENM)

42386 PROTON-NUCLEUS TOTAL CROSS SECTIONS AT 19.3 BeV/c AND HIGH-ENERGY CURRENTS. Horwitz, L. P.; Neumann, H. (Univ. of Denver). Phys. Rev. Lett., 19: 765-7 (Sept. 25, 1967).

Relations among scattering matrices that are direct extensions of elementary particle scattering relations, and should be valid for nuclei, are derived among total cross sections from a previous algebraic approach. The total cross sections and ratio of real to imaginary parts of the forward scattering amplitude are listed for 19.3-GeV/c protons incident on nuclei. (J.F.P.)

42387 RECOIL POLARIZATION AND STRUCTURE OF THE DEUTERON. Ramachandran, G. (Indian Statistical Inst., Calcutta). Nucl. Phys., B2: 565-80(1967).

Expressions for the recoil deuteron polarization tensors and the differential cross section in elementary particle interactions with the deuteron are obtained as functions of five body form factors of the deuteron taking into account the D-state admixture with an arbitrary relative phase. Considering in particular the elastic scattering of pions and photoproduction of neutral pions, suitable measurements of the observables are suggested to estimate the five form factors. It is also shown that measurements of the differential cross section alone at low values of momentum transfer enable the determination of the D-state probability and the relative phase. (auth)

42388 TWO-PARTICLE INELASTIC REACTIONS AND MOVING BRANCH POINTS IN ANGULAR-MOMENTUM PLANE. Ansel'm, A. A.; Dyatlov, I. T. (Ioffe Inst. of Physics and Tech., Leningrad). JETP Lett. (USSR) (Engl. Transl.), 5: 330-2(June 1, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 5: 404-6(June 1, 1967).

The contribution of branch points to the asymptotic amplitudes of two-particle inelastic interactions at large momentum transfers $|t| \gg m^2$, but at $|t| \ll s$ (where s is the square of the total cms energy and m is the nucleon mass) is considered. (J.F.P.)

42389 n-p CHARGE EXCHANGE AS A POLARIZATION ANALYZER OR SOURCE OF HIGH ENERGY POLARIZED BEAMS. Byers, N.; Thomas, G. (University of California, Los Angeles). Phys. Lett., 25B: 233-4(Aug. 21, 1967).

It is noted that on very simple and plausible assumptions, one may infer from the measurements of the differential cross section at 8 GeV/c that n-p charge exchange scattering with $0.25 \lesssim -t \lesssim 0.5$ $(GeV/c)^2$ is a good polarization analyzer or, with polarized target, a source of longitudinally polarized beams. (auth)

42390 DISCONTINUITY IN LARGE ANGLE PROTON-PROTON SCATTERING AND PRODUCTION OF ANTIBARYONS. Kokkedee, J. J. J.; Van Hove, L. (CERN, Geneva). Phys. Lett., 25B: 228-9(Aug. 21, 1967).

The rapid change observed in the angle pp elastic scattering in the laboratory momentum interval $8 \lesssim p_L \lesssim 11$ GeV/c is discussed as a shadow effect of baryon-antibaryon pair creation. At $p_L = 10$ GeV/c, assuming S wave pair creation, it is estimated from the measured pp elastic data that the $B\bar{B}$ pair creation cross-section must be about 2μb. (auth)

42391 MULTIPLE PARTICLE PRODUCTION IN 22.8-GeV/c PROTON-NUCLEON INTERACTIONS. Bhowmik, B.; Shivpuri, R. K. (Univ. of Delhi). Phys. Rev., 160: 1227-38(Aug. 25, 1967).

The contribution of baryon excited states to multiple particle production is studied. The interactions were divided into two categories, viz., those having shower multiplicity less than or equal to four and those having multiplicity greater than four. The features that were studied are the angular distribution, inelasticity, transverse momentum, and center-of-mass momentum of protons and pions. It was found that the characteristics of high-multiplicity events are well accounted for on the basis of the statistical theory, whereas those of low-multiplicity events can be well explained by considering the final-state particles as decay products of isobars. The results indicate the probable dominance of isobars having isospin $\frac{1}{2}$. (auth)

42392 NUCLEON PAIR PRODUCTION IN THE UPPER ATMOSPHERE. Rosen, Stephen (State Univ. of New York at Fort Schuyler, Bronx). Phys. Rev., 160: 1111-12(Aug. 25, 1967).

The production of antiprotons due to collisions of primary cosmic rays with atmospheric nuclei is considered. On the basis of approximate experimental information on nuclear cross sections, an approximate value for the flux of antiprotons from this source is obtained. This flux is found to be about 5–50 times the flux of secondary antiprotons generated by cosmic-ray collisions with interstellar gas nuclei. (auth)

42393 ONE-PION EXCHANGE AND SINGLE-ISOBAR PRODUCTION IN pp COLLISIONS BETWEEN 3 AND 30 GeV. Haber, B.; Yekutieli, G. (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Rev., 160: 1410-15(Aug. 25, 1967).

The one-pion exchange (OPE) amplitude with sharp cutoff at b = 1 F explains well the reaction pp → pN*(1238) between 3 and 15 GeV/c. Similar good results are obtained with the absorption model. The unmodified OPE amplitudes violate unitarity in the entire 3–15-GeV/c momentum range, mainly for impact parameters below b = 0.5 F. The sharp-cutoff and absorption amplitudes satisfy the unitarity condition in the same momentum range. The one-pion exchange with absorption corrections cannot explain the reactions pp → pN*(1410), pp → pN*(1518), and pp → pN*(1688) between 4 and 30 GeV/c. (auth)

42394 TEST OF THE MODIFIED DROPLET MODEL USING THE REACTION $\pi^+ + d \rightarrow p + p$. Libby, L. Marshall; Miyashita, S. (Univ. of Colorado, Boulder). Contract AT(11-1)-1537. Phys. Rev., 160: 1447-9(Aug. 25, 1967).

The droplet optical model modified for application to particle-production reactions in which there is a change of mass has been tested using the production reaction $\pi^+ + d \rightarrow p + p$ at ~3 GeV/c center-of-mass energy. The differential elastic pp and elastic πd cross sections are available from measurement and the differential production cross section has also been measured. It is concluded that, in reasonableness of fits to the angular dependence of the production reaction calculated from the elastic scattering cross sections, the modified droplet model is well-behaved. (auth)

42395 PARTICLE-NUCLEUS INTERACTIONS AND THE REGGE MODEL. James, P. B.; Logan, R. K.; Watson, H. D. D. (Univ. of Illinois, Urbana). Phys. Rev., 160: 1539-41(Aug. 25, 1967).

It is proposed that the Regge-pole model may be applied to the high-energy scattering of particles (π,K,N) by nuclei. The deuteron total cross sections are shown to be consistent with this hypothesis. (auth)

42396 THEORY OF THE NEUTRON–PROTON CAPTURE. Bebel, D.; Kaschluhn, F.; Lewin, K. (Humboldt-Univ., Berlin). Monatsber. Deut. Akad. Wiss. Berlin, 8: 705-8(1966). (In German).

In the theoretical calculation of the total cross section for the neutron–proton capture $n + p \rightarrow d + \gamma$ it is essential that the quantum mechanical results be used as the contribution of the direct γ N interaction and not the values obtained by means of dispersion theory approximation. The origin of the inaccuracy obtained in the dispersion theory calculations occurs not in the dispersion theory approach but in supplementary approximations. The total cross section can also be obtained by means of the form independence approximation. It is shown that the introduction of form dependence corrections changes the result only slightly within the limits of error. (J.S.R.)

42397 COHERENT PRODUCTION OF PARTICLES IN HIGH-ENERGY COLLISIONS. Rybicki, Krzysztof (Institut Badan Jadrowych, Krakow). Postepy Fiz., 18: 267-86(1967). (In Polish).

Processes in which high energy particles interact effectively with the whole nucleus are considered. Basic concepts of such processes and properties of systems produced this way are discussed. The experimental procedure used in a study of coherent production at an energy of 4 to 18 GeV is outlined. The main results obtained in this energy region are given. Some results concerning the coherent production at 200 GeV are also shown. (auth)

Particle Invariance Principles and Symmetries

General

42398 (BMwF-FBK–67-67) UEBER DIE VERBINDUNG INNERER UND AEUSSERER SYMMETRIEN IN DER THEORIE DER ELEMENTARTEILCHEN. (The Connection Between Inner and Outer Symmetries in the Theory of Elementary Particles). Loeffler, G. (Muenster Univ. (West Germany). Institut fuer Theoretische Physik). Aug. 1967. 8p. (In German). Dep.

A discussion of group extensions and the "mass-splitting-theorem" helps to gain insight into the connection between internal and external symmetries. (auth)

42399 (ITEF–476) MATRICHNYE ELEMENTY UNITARNOGO PREDSTAVLENIYA GRUPPY LORENTSA. (Matrix Elements of a Unitary Representation of a Lorentz Group). Verdiev, I. A.; Dadashev, L. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1966. 12p. (In Russian). Dep.

Differential equation systems for the Lorentz group unitary representation matrix elements and recurrent relation for the Lorentz transformation matrix elements were obtained. (auth)

42400 CONSEQUENCES OF UNITARY SYMMETRY FOR REACTIONS WITH THREE PARTICLES AT THE FINAL STATE. Lyulka, V. A. Ukr. Fiz. Zh., 12: 1122-4(July 1967). (In Russian).

Proceeding from the SU(3)-symmetry and using the V-spin formalism the ratios are obtained between the amplitudes of the reactions for generation of three particles. The reactions for generation of mesons, baryons and baryon resonance are considered. The ratios between the amplitudes for both an unbroken symmetry and the case of its break by the half-strong interaction are presented. (auth)

42401 A GENERAL TREATMENT OF THE COMPLEX-ANGULAR-MOMENTUM SU_2 REPRESENTATIONS. Beltrametti, E. G.; Luzzatto, G. (Univ., Genoa. Istituto Nazionale di Fisica Nucleare, Genoa). Nuovo Cim. (10), 51A: 147-68(Sept. 1, 1967).

A generalized notion of representation for SU_2 is shown to depend upon two independent complex parameters λ and γ, λ being the extension of the spin l, γ characterizing the range of the magnetic quantum number μ. A structure of "forked" representations is introduced, to take the relevant properties into account. It is shown that in the analytic extension from the classical situation there is a certain amount of arbitrariness, which leads to different possibilities for the scalar-product definition in the carrier spaces of the representations. Those special aspects of the problem, which were considered previously, enter in this general treatment. (auth)

42402 NONCOMPACT $SU_{3,1}$ EXTENSION OF THE SU_3 SYMMETRIES. Santilli, R. M. (Univ., Turin). Nuovo Cim. (10), 51A: 89-107(Sept. 1, 1967).

The noncompact $SU_{3,1}$ extension of the SU_3 symmetries which is essentially based on the coupling of the following subgroups of $SU_{3,1}$: the SU_3 group with the homogeneous Lorentz group and three nonindependent SU_2 groups with three nonindependent (2 + 1)-dimensional Lorentz groups is investigated. It is found that the essential results of SU_3, representable in the isospin-hypercharge plane, are contained in $SU_{3,1}$ following infinite spectra of supermultiplets distributed along a third axis. (auth)

42403 A REALIZATION OF THE $U_{q,1}$ ALGEBRA IN TERMS OF QUANTUM-MECHANICAL OPERATORS. Santilli, R. M. (Univ., Turin). Nuovo Cim. (10), 51A: 74-88(Sept. 1, 1967).

A realization in terms of quantum-mechanical operators of the Lie algebra of the noncompact unitary $U_{q,1}$ (q = 1,2, . . .) group whose first-order Casimir invariant gives rise to differential equations which can be considered as the covariant extensions of the q-dimensional isotropic harmonic-oscillator equation is investigated. The solutions of these equations and the corresponding construction of the discrete most degenerate representations of the $\underline{U}_{q,1}$ algebra on the Hilbert space $H(M^{q,1})$ of functions defined on the Minkowski space $M^{q,1}$ are investigated. Irreducibility and unitarity are also shown. (auth)

42404 ALGEBRAIC FORMULATION OF DYNAMICAL PROBLEMS. Budini, P. (International Centre for Theoretical Physics, Trieste, Italy). Acta Phys. Austr., Suppl. 4, 118-44(1967).

From 6th International Proceedings on Special Problems in High Energy Physics, Schladming, Austria, Feb. 26–Mar. 9, 1965. See CONF-670216.

It is shown how the method using groups, which from the beginning allow mass splitting, can generate the right energy eigenstates of the physical system, and are suitable for formulating the fundamental dynamical properties of the system in algebraic form, is used for these physical systems. A description is given of old and recent attempts at relativistic theories which can be formulated in the frame of this methodology. (J.F.P.)

42405 THE SITUATION FOR CP SYMMETRY. Treiman, S. (Princeton Univ., N. J.). Comments Nucl. Particle Phys., 1: 89-93(May 1967).

A review of the development of CP symmetry theory is presented. The review begins with a brief mention of the overthrow of parity and charge conjugation invariance in weak interactions and proceeds to recent developments. The neutral meson(K) system, CP and T violation in hadron interactions, and tests of CP and T invariance are discussed. (J.F.P.)

42406 ON A POSSIBLE CONNECTION OF THE SYMMETRIES OF ELEMENTARY PARTICLES WITH THE SYMMETRY OF THE CLEBSCH–GORDAN COEFFICIENTS. Shelepin, L. A. (Lebedev Inst. of Physics, Moscow). Nucl. Phys., B2: 608-14(1967).

The invariants constructed of quantities transforming as representations of the Lorentz group are shown to be possibly classified according to representations of the group SL(3C) or SU_3. This is due to the symmetry properties of the Clebsch–Gordan coefficients which were derived by Regge. It is proposed that the SU_3 symmetry of elementary particles is connected with this property of relativistic invariants, while the SU_6 symmetry between the spin and charge variables is connected with certain symmetry properties of the Clebsch–Gordan coefficients. (auth)

42407 SU(3) ISOSCALAR FACTORS. Chew, C.-K. (McGill Univ., Montreal); Sharp, R. T. Nucl. Phys., B2: 697-712 (1967).

The general nonorthonormalized SU(3) isoscalar factor is expressed as a six-fold sum involving a triply stretched 15-j coefficient which contains a quadruple sum. The symmetry properties of the symmetric isoscalar factor and its relation to the asymmetric isoscalar factor are discussed. Two orthonormalization schemes are discussed which diagonalize respectively a metric operator and a mixed Casimir operator. (auth)

42408 HARMONIC ANALYSIS IN TERMS OF THE HOMOGENEOUS LORENTZ GROUP. Delbourgo, R. (Imperial College, London); Salam, A.; Strathdee, J. Phys. Lett., 25B: 230-2 (Aug. 21, 1967).

Scattering amplitudes for particles of arbitrary mass and spin are expanded in terms of homogeneous Lorentz group representations. The expansion satisfies the group theoretic 0(3,1) boundary constraints in the forward elastic limit and incorporates the correct threshold factors. (auth)

42409 SPONTANEOUS BREAKDOWN OF SYMMETRIES AND ZERO-MASS STATES. Ezawa, H. (Univ., Hamburg); Swieca, J. A. Commun. Math. Phys., 5: 330-6(1967).

In a relativistic field theory Goldstone's theorem is proved without any assumption about the existence of covariant fields and for arbitrary expectation values. (auth)

42410 CURRENT-ALGEBRA SUM RULES FOR STATES OF ARBITRARY MASS AND SPIN. Bander, Myron (Univ. of California, Irvine). Phys. Rev., 160: 1416-20(Aug. 25, 1967).

Sum rules based on current algebra are obtained for the currents evaluated between states of arbitrary spin and mass. Both the infinite-momentum limit and the dispersion method are shown to yield the same result. These sum rules are given explicitly for the crossed-channel amplitudes. (auth)

42411 POINCARE INVARIANCE, CROSSING SYMMETRY, AND STATISTICS. Cho, Byung-ha (Kyungpuk National Univ., Taegu, Korea). New Phys. (Korea), 6: 47-54(Dec. 1966).

Following G. Feldman and P. T. Matthews, the spin-statistics connection and crossing symmetry are given for massive particle of any spin s. This generalization is equivalent to S. Weinberg's developments. (auth)

42412 INVARIANCE GROUPS OF MOTION EQUATIONS WITH COMMUTATOR RINGS. Weicksel, H. (Univ., Mainz). Z. Phys., 205: 291-302(1967). (In German).

An attempt to describe particles by hermitian operators obeying commutator relations leads to a ring of sixteen elements to be represented by matrices of infinite rank. Equations of motion containing elements of the ring are shown to be invariant under charge-conjugation, time-reversal and inhomogeneous Lorentz transformations. Analogs to Pauli- and Gürsey-transformations can also be defined and may be used to introduce isospin and helicity. (auth)

Applications (Electromagnetic and Weak)

42413 (NP–16951) O NESOKHRANENII T-CHETNOSTI V SIL'NOM I ELEKTROMAGNITNOM VZAIMODEISTVIYAKH ADRONOV. (On the T-Violation in the Strong and Electromagnetic Interactions of Hadrons). No. 458. Lobov, G. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1966. 8p. (In Russian). Dep.

The calculation of T-odd angular correlations at the cascade emission of two mixed γ-quanta by a polarized nucleus is fulfilled. The case of the arbitrary multipole structure has been considered. The polarization of the final nucleus was taken into account. The result is that number of the nuclei suitable for the experimental study of T-odd correlations is much increased. (auth)

42414 FURTHER RESULTS ON CP VIOLATIONS. Fitch, Val L. Comments Nucl. Particle Phys., 1: 47-51(Mar. 1967).

A review of experimental and theoretical results for CP violation in the decays of mesons (K^0) is given. The ratios of the amplitudes for these decays and the effects of the superweak interaction are considered. (J.F.P.)

42415 DECAY OF NEUTRAL K-MESONS INTO TWO PHOTONS. Stern, H. (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). Nuovo Cim. (10), 51A: 195-200(Sept. 1, 1967).

A rapid review of the actual knowledge of CP violation and the general formalism of neutral mesons (K) are given. The kinematics of the 2γ decay are examined, and the observable quantities in two extreme cases are computed in terms of phenomenological parameters. In the first one the 2γ decays obey CP invariance but CP violating effects arise through the weak Hamiltonian. These are of the order of 10^{-3}, practically unobservable. But in the second case strong effects are obtained when the 2γ decays violate CP invariance badly; CP violation is then associated with electromagnetic C-violating corrections of the hadronic K decay, and both even and odd CP parts of each $K_1^0 \to 2\gamma$ amplitude are expected to be of comparable order of magnitude. (J.F.P.)

42416 TEST OF TIME-REVERSAL INVARIANCE IN THE DECAY PROCESS $K^+ \to \mu^+\nu e^+e^-$. Chu, W. T.; Ebata, T.; Scott, D. M. (Ohio State Univ., Columbus). Phys. Rev. Lett., 19: 719-22(Sept. 18, 1967).

It is shown that a study of the decay process $K^+ \to \mu^+\nu e^+e^-$ could be a practical experiment to test the t-reversal property of radiative weak decay of hadrons. (auth)

42417 EXPERIMENTS ON TIME-REVERSAL INVARIANCE. Fitch, V. L. (Princeton Univ., N. J.). Comments Nucl. Particle Phys., 1: 117-20(July-Aug. 1967).

Some experiments on time reversal invariance are reviewed. These experiments are neutron decay, the decay of ^{19}Ne, and $K \to \pi + \mu + \nu$ decay. It is concluded that although these experiments represent very substantial improvements in the experimental limits on T invariance, the results cannot be coupled to the observed CP-violating $K_2^0 \to 2\pi$ decay since this coupling is model dependent and the models are flexible enough to accommodate the results. (J.F.P.)

42418 HYPERON DECAYS AND PARTIAL CONSERVATION OF TENSOR CURRENT. Tanaka, K. (Ohio State Univ., Columbus. Univ. of Miami, Coral Gables). Phys. Rev., 160: 1475-9(Aug. 25, 1967). (COO-1545-14).

On the basis of the partial conservation of tensor current (PCTC) hypothesis, sum rules for the magnetic moments of baryons are obtained, one of which yields $\mu^-_\Xi = -1.4 \pm 1.5$ nm. The ratio of D-type coupling to F-type coupling D/F is obtained from the magnetic-moment relations in broken unitary symmetry in SU(3) and SU(6). Sum rules for the transition magnetic moments μ_{BA} of $A \to B + e^- + \bar{\nu}$ are obtained as a consequence of PCTC. The contribution of the magnetic term to the various semileptonic decay rates of hyperons is estimated on the basis of SU(3) and found to be less than 8% of that of the charge term for the vector current. (auth)

42419 SOME CONNECTIONS BETWEEN SUM RULES AND SYMMETRIES. Beg, M. A. B.; Pais, A+ (Rockefeller Univ., New York). Phys. Rev., 160: 1479-89(Aug. 25, 1967).

The question of the existence of consistency conditions arising from the combination of sum rules with internal symmetries is discussed further. The sum rules considered are the forward-scattering Compton and photoproduction rules. A new photoproduction rule is stated. The notion of the support of a sum

rule is introduced: viz., the set of states such that saturation with these states does not generate null solutions for low-energy parameters. Different sum rules generally have distinct supports because of differences in the consistency conditions from rule to rule. Applications of saturation methods to the axial D/F ratio, full and anomalous magnetic moments, and the $\pi^0 \rightarrow 2\gamma$ lifetime are discussed. (auth)

42420 CURRENT COMMUTATOR AND CPT. Rajasekaran, G. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., 160: 1427-8(Aug. 25, 1967).

It is shown that Gupta's commutator theory of CP violation violates the CPT theorem and that the anticommutator form for the current–current interaction is necessitated by CPT invariance alone, irrespective of whether CP is conserved or not. (auth)

Applications (Strong)

42421 (UCRL-17738) 0(4) SYMMETRY AND REGGE POLE THEORY. Wang, Jiunn-ming (California Univ., Berkeley. Lawrence Radiation Lab.). July 27, 1967. Contract W-7405-eng-48. 50p. Dep. CFSTI.

Thesis.

For reactions in which the initial and final states in the t-channel contain equal-mass particles (e.g., $N\bar{N} \rightarrow \pi\pi$) of masses m and m′, it is shown using analytic continuation and Lorentz invariance that the on-mass shell helicity amplitudes in the region $t = 0$, $(m-m')^2 \leq s \leq (m+m')^2$, are invariant under the group 0(4). Decompositions of the amplitudes in irreducible representations of 0(4) (four dimensional partial wave expansions) are obtained and related to conventional partial wave expansions. Poles classified according to the 0(4) group are shown to lead to infinite families of Regge poles. The formalism is developed for arbitrary spins and the case of nucleon-nucleon scattering is studied in detail. The results for the Regge pole structure in NN scattering are stronger than those of the conspirator theory. (auth)

42422 MASS FORMULAS IN THE THEORY OF UNITARY SYMMETRY. Kadyshevskii, V. G. (Joint Inst. of Nuclear Research, Dubna, USSR). Dokl. Akad. Nauk SSSR, 172: 73-5 (Jan. 1, 1967). (In Russian).

In order to obtain the mass formulas in a SU(3)-scheme it is sufficient to add a perturbation with suitable tensor properties to the invariant mass operator. In particular, the Gell–Mann–Okubo formula $(\Xi + N)/2 = (3\Lambda + \Sigma)/4$ occurs if the perturbation is converted as the (33)-component of an octet. An analog of the above formula for quark masses p, n, λ is the relation: $p = n \neq \lambda$. A formula of the Gell–Mann type is derived without depending on concrete expressions for the mass operator that are associated with perturbation theory. It is essential only that the mass operator is diagonal with respect to isotopic spin I and hypercharge Y. It is assumed that in the higher multiplets of SU(3) composed of rotating quark triplets, the average masses of states belonging to a single U′-multiplet are the same. Then a definite relation should exist between the masses of real particles in the same U′-multiplets. Thus it is found that: $(\Sigma^+ + p + \Xi^- + \Sigma^-)/4 = (3/4)(\Lambda + 3\Sigma^0)/4 + (1/4)(n + \Xi^0)/2$. This relation agrees well with experiment (the left part is equal to 1161.4 MeV, and the right part is equal to 1161.5 ± 0.2 MeV). (TTT)

42423 PARTIAL SYMMETRY AND MESON COUPLINGS. Mitra, A. N.; Saxena, R. P. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Lett., 25B: 225-7(Aug. 21, 1967). (IC-67/38).

Schwinger's hypothesis of partial symmetry is used for calculating the couplings of tensor, axial and scalar mesons to vectors and pseudoscalars. The decay widths of principal modes, evaluated on the basis of a universal coupling equal to the isospin coupling, are in good agreement with experiment. (auth)

42424 ON A THEOREM BY CARRUTHERS. Steinmann, O. (CERN, Geneva). Phys. Lett., 25B: 234-5(Aug. 21, 1967).

Carruthers' theorem states that self-conjugate isospin-multiplets with half-integral isospin cannot exist. It is shown that this theorem can be derived from invariance under Lorentz transformations, CTP, and isospin rotations without using any other assumptions. (auth)

42425 RELATIVISTIC THEORY OF SL(6,C) SYMMETRY. Tao, Won Tyk; Enkovski, L.; Kykhtin, V. V.; Montvai, I.; Nguyen Van Hieu (Joint Inst. for Nuclear Research, Dubna, USSR). Acta Phys. Pol., 31: 887-903(May 1967). (In Russian).

The symmetry technique of SL(6,C) with infinite multiplets was developed. By means of homogeneous functions, the unitary concepts of the S, L(6,C) group were constructed and the separations of these concepts to the SU(6) multiplets and $SU(6)_p$ physical multiplets were investigated. The invariant meson–baryon vertex was constructed. On the example of the vertex, the bond between the theory examined with infinite multiplets and nonunitary internally perturbed theory of SL(6,C) symmetry with final multiplets was established. (tr-auth)

42426 O(4) SYMMETRY AND REGGE-POLE THEORY. Freedman, Daniel Z.; Wang, Jiunn-ming (Univ. of California, Berkeley). Phys. Rev., 160: 1560-71(Aug. 25, 1967).

For reactions in which the initial and final states in the t channel contain equal-mass particles (e.g., $N\bar{N} \rightarrow \pi\pi$) of masses m and m′, it is shown, using analytic continuation and Lorentz invariance, that the on-mass-shell helicity amplitudes in the region $t = 0$, $(m-m')^2 \leq s \leq (m+m')^2$ are invariant under the group O(4). Decompositions of the amplitudes in irreducible representations of O(4) (four-dimensional partial-wave expansions) are obtained and related to conventional partial-wave expansions. Poles classified according to the O(4) group are shown to lead to infinite families of Regge poles. The formalism is developed for arbitrary spins, and the case of nucleon-nucleon scattering is studied in detail. Our results for the Regge-pole structure in NN scattering are stronger than those of the conspirator theory. (auth)

42427 PRODUCTION OF 2^+ MESONS AND SU(6) SYMMETRY. Bondyopadhyay, D.; Majumdar, Rabi; Tripathy, K. C. (Univ. of Delhi). Phys. Rev., 160: 1571-3(Aug. 25, 1967).

The sum rules for production amplitudes of 2^+ mesons near threshold in pseudoscalar meson-baryon scattering were studied within the framework of SU(6) symmetry. It is concluded that the nonet of 2^+ mesons should be assigned to the 405 multiplet in view of the fact that some of the well-observed processes are forbidden if these mesons belong to 189. The sum rules based on the assignment of 2^+ mesons to the 405 multiplet of SU(6) are found to be consistent with the experimental data available at present. (auth)

42428 BARYON RESONANCES AS ORBITAL EXCITATIONS OF THE BARYONS. Dobson, Peter N. Jr. (Univ. of Hawaii, Honolulu). Phys. Rev., 160: 1501-5(Aug. 25, 1967).

A simple model of the baryon resonances is proposed in which internal spin-unitary-spin wave functions, belonging to a 56 of SU(6), are coupled to internal orbital angular momentum. It is found that fourteen of the known baryon resonances may be accommodated in this scheme with maximal alignment of L and S. Decays of the resonances are described in the model by an $SU(6)_w$-invariant coupling to the meson 35, with fitted phenomenological parameters representing the effects of internal structure. The agreement with experimental total and partial widths is reasonably good. Of special interest is the fact that consistency of the model calls for the assignment of $J^P = 5/2^-$ to the Ξ^* (1933), instead of $5/2^+$ as is usually assumed. (auth)

42429 SU(3) IN A BYERS–YANG MODEL. Cushing, James T. (Univ. of Notre Dame, Ind.). Phys. Rev., 160: 1506-10(Aug. 25, 1967). (COO-427-63).

For octet-octet scattering between a $J^P = 0^-$ pseudoscalar meson and a $J^P = 1/2^+$ baryon, an expression is derived for the departures of the total cross sections from the common value predicted by exact SU(3) and an Okun'–Pomeranchuk (OP) rule. The exchange amplitudes are treated as corrections to the OP rule. It is first established that the appreciable departures of the total cross sections from a common SU(3) limit can not be attributed wholly to the small violations of the OP rule observed. Under the assumptions of an OP rule and SU(3) symmetry broken subject to exact $SU(2)_I$ and hypercharge conservation, an expression is derived for the asymptotic total cross sections for octet-octet scattering in terms of five real constants. An extended Byers–Yang model is used to obtain the invariant differential cross section for $\pi^-p \rightarrow \eta n$, and it is shown that fairly accurate measurements of two differential cross sections of the type $P + B \rightarrow P' +$ hyperon at high energy (~20 BeV/c) would allow a prediction of all the PB total cross sections within the framework of the model. (auth)

42430 MESON–BARYON SCATTERING IN BROKEN $SU(6)_W$. Gupta, Sachchida Nanda (Univ. of Delhi. National Physical Lab., New Delhi). Phys. Rev., 160: 1343-6(Aug. 25, 1967).

The scattering processes like $P + B \rightarrow P + B$ and $P + B \rightarrow P + D$ were studied within the framework of broken $SU(6)_W$, the breaking being provided by a W-spin scalar spurion having $I = 0 = Y$ and belonging to the 35-dimensional adjoint representation of $SU(6)_W$. It is found that many of the bad results of the exact $SU(6)_S$ and exact $SU(6)_W$ schemes are absent. At the same time, some of the results which agree with experiment are retained. The Johnson–Treiman relations, however, are no longer valid. (auth)

42431 INFINITE-COMPONENT WAVE EQUATIONS WITH HYDROGENLIKE MASS SPECTRA. Nambu, Yoichiro (Univ.

of Chicago). Phys. Rev., 160: 1171-81(Aug. 25, 1967). (COO-264-371).

Continuing a previous work, various models of relativistic wave equations are considered which have an infinite number of components. By combining a unitary representation of SO (4,2) and the ordinary finite (Dirac) representation of the Lorentz group, it is possible to construct equations which produce hydrogenlike mass spectra. However, they are also accompanied by redundant, or unphysical, solutions. In the nonrelativistic limit, on the other hand, the equations obtained can be shown to be mathematically equivalent to the Schrödinger equation for the hydrogen atom. This suggests that the method of infinite-component wave equations may be a useful tool in exploring the physics of strong interactions. A general discussion is made about the principles and problems that will be relevant in pursuing such a program. (auth)

Quantum Field Theories

Refer also to abstracts 42376, 42410, and 42411.

42432 QUANTUM FIELD THEORY AND GENERALIZED FUNCTIONS. Rohrlich, F. (Syracuse Univ., N. Y.). Acta Phys. Austr., Suppl. 4, 228-68(1967).

From 6th International Proceedings on Special Problems in High Energy Physics, Schladming, Austria, Feb. 26-Mar. 9, 1965. See CONF-670216.

The present state of quantum field theory is reviewed following the approach of asymptotic quantum field theory. This review includes generalized functions, analytic functionals and the class Δ_+^β of generalized functions, the free field equation $K^N a = 0$, operator derivatives, the operators P_{12} and their algebra, causality and the GLZ expansion, the Pugh equation, current formalism, and Feynman diagrams and boundary conditions. This quantum field theory is based entirely on free fields and sources. The latter are obtained from the S-operator by operator derivatives with respect to these free fields. (J.F.P.)

42433 QUANTUM FIELD THEORY IN DE SITTER SPACE. Thirring, W. (Univ. of Vienna). Acta Phys. Austr., Suppl. 4, 269-87(1967).

From 6th International Proceedings on Special Problems in High Energy Physics, Schladming, Austria, Feb. 26-Mar. 9, 1965. See CONF-670216.

An investigation is made of how quantum field theory works for systems invariant under the de Sitter group. Two different models of space-time, both invariant under the de Sitter group, are considered as possible representations of the cosmos. Restriction is made to the main difference between the Poincaré and de Sitter groups, namely the definiteness of the energy. (J.F.P.)

42434 PROJECTION OPERATORS IN QUANTUM THEORY OF RELATIVISTIC FREE FIELDS. Aurilia, A.; Umezawa, H. (Univ., Naples). Nuovo Cim. (10), 51A: 14-39(Sept. 1, 1967).

It is known that there is a particular kind of projection operator, usually denoted by $d(\partial)$, in terms of which the quantum theory of relativistic free fields can be put in a simple and synthetic form. A method by which the operator $d(\partial)$ can be calculated without any use of the wave equations is presented. It will be shown also that the wave equations can be derived from the knowledge of $d(\partial)$. As an illustration a detailed consideration of the field of spin $^3/_2$ is presented. (auth)

42435 DIFFICULTIES WITH THE DEFINITION OF CHARGE IN AXIOMATIC QUANTUM FIELD THEORY. de Mottoni, P. (Scuola Normale Superiore, Pisa, Italy). Nuovo Cim. (10), 51A: 128-46(Sept. 1, 1967).

Two basic approaches to define the charge are considered, and the difficulties arising from them in quantum field theory are studied. A mathematically compact treatment is given to the proposals which were made to overcome them. The relation between definition of charge and vanishing of the divergence of the current is investigated, and some related theorems are derived. (auth)

42436 YUKAWA COUPLING OF QUANTUM FIELDS IN TWO DIMENSIONS. I. Glimm, James (Massachusetts Inst. of Tech., Cambridge). Commun. Math. Phys., 5: 343-86(1967).

A renormalization procedure is proposed. It gives rigorous mathematical meaning to the infinite cancellations in this model. A space cutoff is introduced in the interaction term V and so V has the form $\int_{|x|\le K} V(x)dx$, but there are no momentum cutoffs in V. There is an infinite constant and an infinite boson mass renormalization in this model. The main result is that the renormalized Hamiltonian is rigorously defined as a bilinear form in the Fock Hilbert space. (auth)

42437 NEW FORM OF THE VECTOR POTENTIALS FOR A SOURCE-FREE VECTOR FIELD. Rubinowicz, A. (Polish Academy of Sciences, Warsaw). Acta Phys. Pol., 31: 835-64 (May 1967). (In German).

New expressions for three- and two-dimensional vector potentials of source-free vector fields were reported. The three-dimensional vector potentials are suitable both for the representation of three- and two-dimensional source-free vector fields. The two-dimensional vector potentials are usable for specification of two-dimensional source-free vector fields. When an expression for the vector potential was used, which was given by a spatial integral, the new vector potentials in the two-dimensional case were represented by line integrals over certain semi-rays or finite straight-line distances. In the two-dimensional case, the integration can be extended over random plane curves. In opposition to the usual expression for the vector potential, the new formulas are usable also for source-free vector fields which are at the same time eddy-free and can be used in the case of vector fields which possess in the finite or infinite certain singularities. The new vector potentials are in general not source-free. The application of the new formulas was explained by examples. An expression for the tensor potential of a source-free tensor field was also reported. The most important application range for the form given for the vector and tensor potentials is the Kirchhoff diffraction theory of scalar or vector fields since these potentials permit a cleavage of the total wave process into a geometric-optical diffraction wave and a diffraction wave emanating from diffracting boundaries. (tr-auth)

42438 RELATIVISTIC, 3-DIMENSIONAL, 2-BODY INTEGRAL EQUATIONS. ON-SHELL AND OFF-SHELL FORMALISMS. Namyslowski, J. M. (Stanford Univ., Calif.). Contract AF49 (638)-1389. Phys. Rev., 160: 1522-39(Aug. 25, 1967).

Covariant on-shell and off-shell formalisms are presented on the basis of the Bethe-Salpeter equation and the 2-particle unitarity condition. The 2-body theory is formulated in terms of the relativistic 3-dimensional integral equations of the Low type. Three approaches are presented which take into account differently the left-hand cuts, besides including the 2-particle right-hand cut. The partial-wave expansion and some methods of solving the reduced equations are pointed out. A covariant formulation and a generalization for arbitrary masses are included in full detail. (auth)

42439 COMPOSITE PARTICLES IN FIELD THEORY. Divakaran, P. P. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., 160: 1468-74(Aug. 25, 1967).

Some aspects of the field-theoretical description of composite particles are studied. Using the most general local-field operator that is possible for the composite particle, it is shown that (I) if the theory can be expressed in terms of a Lagrangian, the "indifference hypothesis" of Feynman is true, i.e., the Lagrangian can be written as a function of any one of all possible irreducible sets of fields (in particular, sets including composite fields), without changing the S operator of the theory; (II) it is impossible for all particles to be composite—a bootstrap is thus incompatible with the general principles of local-field theory; and (III) a necessary condition for a composite particle to be described by a local field is that its wave-function (field) renormalization constant should vanish. (auth)

42440 CASTILLEJO-DALITZ-DYSON POLES AND ASYMPTOTIC FIELDS. Jernow, Stanley; Kazes, Emil (Pennsylvania State Univ., University Park). Phys. Rev., 160: 1428-31(Aug. 25, 1967).

The meaning of Castillejo-Dalitz-Dyson poles (CDD poles) in the field-theoretic context of a boson separable-potential model is studied. Because the asymptotic-field operators for this model depend upon the D function, it is possible to insert CDD poles into these fields and to gauge their effect. It is found that CDD poles have a profound influence: Their presence prevents the in-fields from satisfying canonical commutation relations. A return to the free-particle algebra is possible, however, if new particles are inserted into the theory, one for every pole. These new particles are unstable, thus confirming the link between CDD poles and instability. A further consequence of this work is the development of a method for constructing Hamiltonians which, a priori, yield scattering amplitudes containing CDD poles. (auth)

42441 EQUAL-TIME COMMUTATION RELATIONS OF THE ISOVECTOR CURRENT DENSITIES. Meyer, James W.; Suura, H. (Univ. of Minnesota, Minneapolis). Phys. Rev., 160: 1366-74 (Aug. 25, 1967).

The one-particle matrix elements of the local equal-time commutators of the isovector currents are derived by applying the Dyson representation to the causal parts of the invariant absorptive parts. Assuming the equal-time commutation relation be-

tween the total charge and charge density and also assuming certain asymptotic limits for the Dyson spectral function, the local equal-time commutation relations between various components of the currents can be generated. It is shown that, for a reasonable asymptotic behavior of the spectral function, the charge-space component has no antisymmetric (in isospin) Schwinger terms, but involves two possible q-number symmetric Schwinger terms, and that the space-space components can have no antisymmetric Schwinger terms. It is pointed out that as the asymptotic behavior becomes worse, the equal-time commutation relations can no longer be uniquely defined. (auth)

42442 REGGEIZATION OF ELEMENTARY PARTICLES. Pradhann, T.; Passi, J. N. (Saha Inst. of Nuclear Physics, Calcutta). Phys. Rev., 160: 1336-43(Aug. 25, 1967).

Except in the scattering of vector bosons by spin-½ nucleons, elementary particles of conventional field theory correspond, in general, to Kronecker-delta singularities in the complex angular-momentum plane of the scattering amplitude, and if there is a Regge trajectory, it does not pass through the elementary-particle pole. However, this Regge trajectory induces a pole in the vertex function and a zero in the propagator of the elementary particle. These induced effects are such that under certain conditions on the renormalization constants, all the Kronecker-delta singularities cancel each other and the Regge trajectory moves to the elementary-particle pole. This Reggeization of elementary particles is demonstrated in a soluble-model field theory. (auth)

42443 SELF-INTERACTING REAL SCALAR QUANTUM FIELD THEORIES WHICH ADMIT STATIONARY STATES AND A CLASSICAL LIMIT. Rosen, Gerald (Drexel Inst. of Tech., Philadelphia). Phys. Rev., 160: 1278-82(Aug. 25, 1967).

Conditions for a local, essentially nonlinear, real scalar field theory to admit vacuum, one-quantum, and quasiclassical stationary states are derived with the Rayleigh-Ritz procedure for functionalities. It is shown that only so-called Class A theories, for which the self-interaction energy density divided by the field squared is uniformly bounded for all values of the field, admit wholly acceptable one-quantum and quasiclassical stationary states. The Class-A theories appear to be effectively linear, with no macroscopically observable self-interaction, in the classical limit. (auth)

42444 QUANTUM THEORY OF PARAMETRIC AMPLIFICATION. II. Mollow, B. R.; Glauber, R. J. (Harvard Univ., Cambridge, Mass.). Phys. Rev., 160: 1097-1108(Aug. 25, 1967).

The analysis of the quantum-mechanical parametric amplifier begun in the preceding paper is extended to describe the joint quantum state of the two interacting modes of oscillation of the system. Equations are derived for the time evolution of the Schrödinger density operator. Comparison with classical theory is made by describing the state of the quantum-mechanical system by means of the P representation. The time evolution of the weight function $P(\alpha,\beta,t)$ for this representation, and of the corresponding Wigner distribution function $W(\alpha,\beta,t)$, is found. A decoupled form for the equations of motion for the field variables is exhibited which simplifies the solutions for these functions. It is shown that the amplification process gives rise to a correlation between the two mode amplitudes which becomes exceedingly strong with increasing time. The relation of this correlation to the time development of the functions $P(\alpha,\beta,t)$ and $W(\alpha,\beta,t)$ is discussed. (auth)

42445 QUANTUM THEORY OF PARAMETRIC AMPLIFICATION. I. Mollow, B. R.; Glauber, R. J. (Harvard Univ., Cambridge, Mass.). Phys. Rev., 160: 1076-96(Aug. 25, 1967).

The amplification of electromagnetic fields is analyzed in a quantum-mechanical context by discussing the behavior of a simple theoretical model of the parametric amplifier. The statistical properties of the amplifier fields are described by means of the time-dependent density operator for the system. In doing this, extensive use is made of the coherent states and the P representation of the density operator, which provide a quantum-mechanical description of the fields closely resembling their classical description. Explicit solutions are obtained for the density operator for either of the two field modes for a variety of initial states of the modes. Initial states considered include combinations of coherent states, chaotic mixtures, and n-quantum states. Particular attention is given the behavior of the amplifier fields in the limit of large amplification. The conditions are established under which the amplification process leads in this limit to the existence of a non-negative P representation for the density operator for a single mode of oscillation. (auth)

42446 FEYNMAN FUNCTIONS ASSOCIATED WITH THE SIXTH-ORDER LADDER DIAGRAM. Westwater, J. M. (Eidgenossische Technische Hochschule, Zurich). Helv. Phys. Acta, 40: 596-638(1967).

The analytic structure of those Feynman functions associated with the sixth order ladder diagram which do not have second type singularities is studied by the homological method. Previous calculations by P. Federbush are criticized. Some general conjectures concerning the structure of Feynman functions are put forward. (auth)

42447 TOPICS IN THE THEORY OF LIE FIELDS. Lowenstein, John Hood. Urbana, Ill., Univ. of Illinois, 1966. 94p. Thesis.

Several aspects of the theory of Lie fields (for which the commutator of the field operators at two space-time points is linear in the field, so that one has an infinite-dimensional Lie algebra) are discussed. It is shown that, contrary to what is currently believed, the existence of scalar Lie fields is not precluded by the algebraic considerations of inhomogeneous Lorentz invariance and weak locality alone. A partial categorization of the wide variety of possible scalar Lie field structures is derived, and the simplest types of examples are presented. A Lorentz-invariant representation of one of these examples is obtained. A vector Lie field associated with the coordinate transformations of differential geometry is discussed as the simplest example of a Lorentz-invariant, strictly local Lie field having a Lorentz-invariant vacuum representation. Finally, the possible usefulness of Lie fields is discussed in two contexts: in the quantum-mechanical formulation of gauge invariance, and in the description of nonrelativistic many-body systems (where, of course, the Lie fields are defined over Euclidean three-space). The latter provides an alternative to the traditional equal-time formulation in terms of fields satisfying canonical commutation or anticommutation relations. (Disser. Abstr.)

Scattering Theory

42448 (AD-644980) KINEMATICS OF MULTIPARTICLE PROCESSES. Research Paper. Jacobson, Donald A. (Douglas Aircraft Co., Inc., Huntington Beach, Calif. Advanced Research Lab.). Apr. 1966. 42p. (DARL-7). CFSTI.

A thorough analysis is made of the kinematics of a general scattering process involving N particles. The following structural properties are proved for the physical region: The physical regions for individual channels are connected and mutually disjoint. The entire physical region can be decomposed into a sum of three real analytic manifolds of dimension 3N-10, 2N-6, and N-3, plus a finite set of points. The physical region can be imbedded in a connected 3N-10 dimensional analytic set, which in turn can be decomposed into a sum of three complex analytic manifolds of dimension 3N-10, 2N-6 and N-3, plus a finite set of points. (auth)

42449 (AD-644991) ANALYTICITY PROPERTIES OF UNITARY INTEGRALS. Research Paper. Jacobsen, Donald A. (Douglas Aircraft Co., Inc., Huntington Beach, Calif. Advanced Research Lab.). Dec. 1966. 58p. (DARL-19). CFSTI.

A general unitary integral is analytically continued, the purpose being to obtain the domain of holomorphy of the integral in terms of the domains of holomorphy of the amplutudes occurring in the integrand. The amplitudes are assumed to be analytic on Riemann domains whose structure is restricted only by certain assumptions found to be prerequisites for an analytic continuation of the unitary integral. The Riemann domains allow for the possibility of an infinite number of singularities of an arbitrary type, and natural boundaries may occur. The analytic continuation is carried out explicitly in terms of scalar variables. All difficulties associated with the use of scalar variables are resolved to give an analytic continuation paralleling that in momentum space. (auth) (TAB)

42450 (ITEF-486) OPTICHESKAYA TEOREMA V TEORII MNOGOKRATNOGO RASSEYANIYA VOLN. (Optical Theorem in the Theory of Multiple Scattering of Waves). Barabanenkov, Yu. N.; Finkel'berg, V. M. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1967. 15p. (In Russian). Dep.

On the basis of general Dyson and Bethe-Salpeter equations which can be satisfied by the mean and double mean propagator in a nonabsorbing medium, the optical theorem in the theory of multiple wave scattering is proved. From this theorem the antihermitian part of the mass operator (the kernel of the Dyson equation) is expressed through the antihermitian part of the mean propagator and through the intensity operator (the kernel of the Bethe-Salpeter equation). Expansions of the optical theorem in small parameters are considered. It is shown that two types of

the mass and intensity operators of the expressions practically used (in powers of the effective potential correlation function in the case of a continuous scattering medium and the cluster parameter in the case of a discrete scattering medium) satisfy the optical theorem in the first and the second order of the expansion parameter. In conclusion a derivation of the transport equation in Foldy's model is discussed in the frameworks of the optical model. (auth)

42451 LOW-ENERGY SCATTERING BY SINGULAR POTENTIALS IN THE LINEARIZED APPROXIMATION TO CALOGERO'S EQUATION. Krueger, H. (Univ., Freiburg i.B.). Z. Phys., 205: 338-41(1967).

The linearized Calogero equation for tan $\delta_1(r)$ was never applied to singular potentials with a repulsive core. It is shown that the solution can be written in the form of integrals. Even in the low-energy limit rough estimates can at least be obtained. This can be seen from a comparison of scattering-lengths calculated, both exactly and approximately, for negative-power potentials. (auth)

42452 NONSENSE, CONSPIRACY, AND POSSIBLE SINGULAR RESIDUES IN REGGE POLE THEORY. Goldberger, Marvin. Comments Nucl. Particle Phys., 1: 63-5(Mar. 1967).

The discussion of nonsense, conspiracy and possible singular residues in Regge pole theory includes various aspects of Regge theory when one is dealing with particles with spin. Various examples showing the effects of spin in Regge pole theory are reviewed. (J.F.P.)

42453 IMMOVABLE SINGULARITY OF THE SCATTERING AMPLITUDE FOR THE STRONGLY INTERACTING PARTICLES AT THE VANISHING FIELD COUPLING CONSTANT. Lomsadze, Yu. M.; Tokar, S. S. (Uzbek State Univ., Samarkand, USSR). Ukr. Fiz. Zh., 12: 1141-3(July 1967). (In Russian).

It is shown that the ≪nonphysical≫ behavior of the higher approximations of the Bethe–Salpeter potential for the most realistic Hamiltonians of strong interactions may be consistent with the absence for the amplitude of both the essential singularity in the s-plane at infinity and the immovable singularity at the point $g^2 = 0$. This possibility may be realized in the assumption that the vicinity e(r) of holomorphy of the exact Bethe–Salpeter potential in the g^2-plane vanishes as $r \to 0$. The potential gives a good example imitating this possibility for quantum field theory. (auth)

42454 S-MATRIX SINGULARITY STRUCTURE. Polkinghorne, J. C. (Univ., of Cambridge, Eng.). Acta Phys. Austr., Suppl. 4, 187-211(1967).

From 6th International Proceedings on Special Problems in High Energy Physics, Schladming, Austria, Feb. 26–Mar. 9, 1965. See CONF-670216.

A survey of some of the basic ideas and results is made in an effort to determine the singularity structure of the S-matrix. The methods illustrated can be generalized to show that all physical region singularities occur only on the positive α arcs of Landau curves and their discontinuities are given by Cutkosky integrals. (J.F.P.)

42455 SUPERCONVERGENCES FOR CROSSING-EVEN AMPLITUDES. Gatto, R. (Univ., Florence. Istituto Nazionale di Fisica Nucleare, Florence). Nuovo Cim. (10), 51A: 212-13 (Sept. 1, 1967).

It was previously pointed out that an amplitude $\phi(\nu)$ satisfying an unsubtracted dispersion relation satisfies the superconvergence relation $\int_{-\infty}^{+\infty} \mathrm{Im}\ \varphi(\nu)\ d\nu = 0$. This relation is trivially satisfied from crossing even amplitudes. For a crossing even amplitude under the same assumptions one can write the superconvergence relation $\int_{-\infty}^{+\infty} \mathrm{Re}\ \varphi(\nu)\ d\nu = 0$. These two equations are independent and give the full set of superconvergence relations. (J.F.P.)

42456 "NUCLEAR DEMOCRACY" AND THE HIGH-ENERGY SCATTERING OF A COMPOSITE PARTICLE. Sawada, T. (Tokyo Univ. of Education). Nuovo Cim. (10), 51A: 208-11(Sept. 1, 1967).

In order to reconcile composite particle scattering with nuclear democracy, the postulate that every elastic scattering has the same type of high-energy behavior is introduced. Then the high-energy behavior consistent with this postulate is examined. That is, the Regge singularities (pole, dipole, cut, etc.), which dominate the high energy behavior in such a way that the scatterings $a + b \to a + b$ and $aa + b \to aa + b$ have the same type of high-energy behavior, are determined. (J.F.P.)

42457 DAUGHTERS FROM ANALYTICITY PLUS CROSSING SYMMETRY. Dean, N. W. (Cambridge Univ., Eng.). Nuovo Cim. (10), 51A: 191-4(Sept. 1, 1967).

It is shown that the necessity for the daughter trajectories, $\alpha_n(0) = \alpha(0) - n$ in the case of unequal masses for the Regge trajectories $\alpha(t)$ implied by analyticity requirements in a Khuri-pole treatment of the scattering amplitude, follows simply from the principles of crossing symmetry and Hermitean analyticity. The scattering processes involving four spinless particles are considered. (J.F.P.)

42458 APPROXIMATELY SEPARABLE OFF-ENERGY-SHELL t-MATRICES AND THEIR APPLICATIONS. Reiner, A. S. (Weizmann Inst. of Science, Rehovoth, Israel). Nuovo Cim. (10), 51A: 1-13(Sept. 1, 1967).

Some separable approximations for off-energy-shell, partial-wave scattering matrices are rederived under weaker conditions than previously stated. Such a generalization is desirable for applications of Fadde'ev techniques in nuclear-reaction theory and statistical physics. It enables the incorporation of an unlimited number of bound states or resonances in each partial wave without increase of the number of coupled channels in the Fadde'ev equations. For the case of S-wave scattering from a square well the exact off-energy-shell t-matrix is compared with some separable approximations. A special one, suggested by Noyes, is far superior to other approximations investigated. Possible causes for this behavior are discussed. (auth)

42459 ANGULAR MOMENTUM DEPENDENT POTENTIALS. Cronstrom, C. Kgl. Danske Vidensk. Selsk., Det, Mat.-Fys. Medd., 35: 1-35(1967).

The properties of the most general local two-body potential for elastic scattering of scalar particles are investigated. This potential is angular momentum dependent. (Arbitrarily energy dependent potentials are ruled out by general symmetry and invariance arguments.) In particular, we investigate the momentum space representation of the angular momentum dependent potential, and show that it is characterized by a particular off shell behavior. By considering the partial wave Lippmann–Schwinger equation, we establish in a rather simple manner the existence of a p-fold class of phase equivalent potentials (containing p local, angular momentum dependent potentials), where p equals the number of bound states in the partial wave under consideration. In this connection, we show that a potential, which is defined by using a perturbative expansion of the S-matrix from field theory, can be chosen to be local and angular momentum dependent, provided the expressions representing the diagrams included in the potential satisfy simple regularity conditions. There does not, however, seem to exist any simple relation (which does not involve the inverse of the Greens function) between a given non-local potential and the corresponding phase equivalent local and angular momentum dependent potential. As an illustration, we make some numerical calculations with a non-local single-particle exchange potential. The adiabatic approximation is investigated in this case, and is shown to be quite inaccurate for a strong attractive potential. (auth) (DENM)

42460 COMPUTATIONAL ALGORITHMS FOR PARTICLE SCATTERING. Yakovlev, L. G.; Girin, I. A. (Inst. of Nuclear Physics, Tashkent. Ul'yanovsk State Pedagogical Inst., USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1986-94(Dec. 1966). (In Russian).

Collision of a particle beam with the surface of a body in which the scattering centers are distributed uniformly is assumed. Paired collisions with scattering at each event over any angle take place in succession. The angular distribution of particles reflected from the surface is to be found. An expression is written for the probability of particle reflection, and this expression is integrated over a solid angle with the use of a series expansion in Legendre polynomials. The angular distribution of reflected particles is obtained from the probability density by iteration. It is also possible to find the average depth of particle penetration into the substance after a fixed number of collisions, and the total averaged depth of penetration (average over the number of collisions) by calculation on a computer. Forward scattering is also considered. (TTT)

42461 POLARIZATION QUESTIONS IN HIGH ENERGY SCATTERING. Phillips, R. J. N. (Atomic Energy Research Establishment, Harwell, Eng.). pp 273-81 of Polarized Targets and Ion Sources, Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, [1967].

From Conference on Polarized Targets and Sources, Saclay, France, Dec. 5–9, 1966. See CONF-661205.

The spin dependence in high energy elastic scattering is discussed and πN scattering is treated as an example. A discussion of Regge poles is also presented. (W.H.K.)

42462 UNIVERSAL INTERACTION OF REGGE PARTICLES WITH VECTOR AND SCALAR CURRENTS. Migdal, A. A. JETP Lett. (USSR) (Engl. Transl.), 5: 332-4(June 1, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 5: 407-9(June 1, 1967).

The interaction F_i, (A) = $\langle A|\int d^3x\bar{q}(x)\gamma_0\lambda_i q(x)|A\rangle$ (1) and $S_i(A) = \langle A|\int d^3x\bar{q}(x)\lambda_i q(x)|A\rangle$ (2) where $F_i(A)$ and $S_i(A)$ are the vertices for the emission of a reggeon V_i or T_i by a particle A; the four-momentum of the reggeon is assumed equal to zero; i = 0,1, ..., 8

is the unitary index; $q(x) = (p, n, \lambda)$ is the quark operator; γ_0 is a Dirac matrix; λ_i are Gell-Mann matrices ($\lambda_0 = \sqrt{2/3}\,1$); the matrix element in (2) is chosen by definition in the rest frame of particle A. The normalization of $|A\rangle$ is such that for quarks $F_i(q) = S_i(q) = \lambda_i$. This interaction is considered without the aid of the quark model. It is shown that this eliminates the contradiction with the hypothesis of constant cross sections. (J.F.P.)

42463 A NOTE ON THE BRYSK APPROXIMATION OF PHASE SHIFTS. Michalik, B. (Inst. of Plasma Physics, Prague). Czech. J. Phys., 17: 757-60(1967).

The Brysk approximation of phase shifts is derived in a manner differing from that used in the original study. The exact wave function is then replaced by its approximation, valid for small values of r in a general integral expression for phase shifts. The approximation obtained is again the Brysk approximation. For the sake of simplicity, the scattering of a nonrelativistic particle by a centrally symmetric potential is considered in all cases. (auth)

42464 MODIFIED REGGE REPRESENTATION. Mukherjee, Suprokash (Saha Inst. of Nuclear Physics, Calcutta). Phys. Rev., 160: 1546-9(Aug. 25, 1967).

A new Regge-type representation for the partial-wave scattering amplitude A (λ,k) is proposed, which has correct asymptotic behavior for small k and large λ. The possibility of making the background integral small is also explored. (auth)

42465 FURTHER STUDIES OF A RECENT REGGE REPRESENTATION. Abbe, W. J. (Univ. of Michigan, Ann Arbor); Gary, G. A. Phys. Rev., 160: 1510-18(Aug. 25, 1967).

The modified Cheng representation (MCR) is evaluated for S, P, and D waves with the potentials $-1.8e^{-r}/r$ and $-5e^{-r}/r$, the former being strong enough to have one bound state near the S-wave threshold, while the latter is nearly strong enough to have a P-wave resonance. Good agreement is found with exact results with only one trajectory input, the agreement being better than the Cheng representation (CR) with three trajectories. Although both representations, the MCR and the CR, are automatically unitary, the results are a considerable improvement over the earlier modified Khuri representation, which was not unitary—especially for the more attractive potential $-5e^{-r}/r$. Residues above threshold are also calculated and compared with the exact results, while reduced residues both above and below threshold are calculated via the MCR, and in all cases good agreement with exact results is obtained. Finally, a simple approximation to the reduced residue below threshold is noted to be quite accurate in potential theory, and may provide a simple and accurate means of estimating high-energy total cross sections and diffraction widths. (auth)

42466 GRIBOV-POMERANCHUK POLES IN SCATTERING AMPLITUDES. Mandelstam, Stanley; Wang, Ling-Lie (Univ. of California, Berkeley). Phys. Rev., 160: 1490-3(Aug. 25, 1967). (UCRL-17489).

It is shown that the argument of Gribov and Pomeranchuk for the existence of fixed poles in the J plane at "nonsense" values of J goes through the presence of cuts, even though their argument for an essential singularity then fails. Such poles have no effect on the asymptotic behavior but, in cases where the contribution of the third double-spectral function is large, they will invalidate both the Schwarz superconvergence relations and the presence of dips in the asymptotic region. A Regge trajectory will not choose sense or nonsense at a point where it passes through an integer of the wrong signature. (auth)

42467 ELASTIC UNITARITY AND REGGE-CUT DISCONTINUITIES. Bronzan, J. B.; Jones, C. Edward (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev., 160: 1494-6(Aug. 25, 1967). (MIT-2098-324).

The constraints imposed on Regge-cut discontinuities by elastic unitarity are examined. It is found that discontinuities must be singular at their endpoints, and, contrary to published examples, must vanish there. Particular attention is given to "wrong-signature" negative integer angular momenta in the spinless problem. There, one Regge cut must exactly mask the elastic unitarity cut; its discontinuity contains a pole in the angular momentum. The results modify the usual expression for the contribution of a cut to high-energy scattering in crossed channels. (auth)

42468 CONTOUR DISTORTIONS IN RELATIVISTIC THREE-PARTICLE SCATTERING EQUATIONS. Nuttall, J. (Texas A and M Univ., College Station). Phys. Rev., 160: 1459-67 (Aug. 25, 1967).

It is shown how to relate the physical three-baryon scattering amplitude as given by a generalized Bethe–Salpeter equation to the solution of an integral equation with a L^2 kernel. This is done by demonstrating that the contours for the integration variables in a perturbation contribution to the amplitude may be distorted so that no propagator vanishes. The method is an extension of techniques used earlier by Tiktopoulos for the two-particle Bethe–Salpeter equation. The results hold for center-of-mass energies less than half way to the threshold for production of a meson. (auth)

42469 SEPARABLE OPERATORS IN SCATTERING THEORY. Gillespie, John (Stanford Univ., Calif.). Phys. Rev., 160: 1432-40(Aug. 25, 1967). (SLAC-PUB-296).

A general theory of nonlocal, separable operators in scattering theory is developed on the basis of variational techniques and eigenvalue analysis. The formalism gives as limiting cases the three-particle isobar model as well as the quasiparticle formalism. The extreme sensitivity of off-shell multiparticle theories to calculation approximation schemes is minimized by our methods. The theory provides optimal systematic extension and improvement of several multiparticle models. (auth)

42470 ISOSPIN CROSSING MATRICES. Neville, Donald E. (Univ. of California, Livermore). Phys. Rev., 160: 1375-83(Aug. 25, 1967). (UCRL-70059).

The rules for expressing the isospin crossing matrix for a two-body scattering process as a 6-J symbol are summarized and derived. It is shown that rules for doing this previously derived in the literature are incomplete, besides being too complicated. The appendices gather together from the widely scattered literature a number of results useful for calculating and checking crossing matrices, not only for isospin but for the higher groups as well. (auth)

42471 HIGH-ENERGY INTERACTIONS AND A MULTI-REGGE-POLE HYPOTHESIS. Zachariasen, F.; Zweig, G. (California Inst. of Tech., Pasadena). Phys. Rev., 160: 1326-9(Aug. 25, 1967). (CALT-68-117).

It is assumed that in certain well-defined kinematic regions, production amplitudes may be described as due to the exchange of a number of Regge poles, and formulas are given expressing the amplitude in terms of the permitted trajectories. Experimental tests and consequences of the hypothesis are discussed. Tests should be possible at present accelerator energies. The hypothesis leads to strong damping of production cross sections in the invariant momentum transfers, and therefore could serve as the basis for the assumptions of a previous paper. (auth)

42472 SPIN DEPENDENCE OF HIGH-ENERGY SCATTERING AMPLITUDES. I. Mueller, A. H.; Trueman, T. L. (Brookhaven Lab., Upton, N. Y.). Phys. Rev., 160: 1296-1305(Aug. 25, 1967). (BNL-11223).

A formalism, useful for discussing spin dependence of scattering amplitudes in terms of complex angular momentum, is given. The question of the spin dependence of elastic scattering amplitudes, its relationship to coupling to Regge poles, fixed poles in the angular-momentum plane, and superconvergence relations are discussed. It is concluded that general principles permit the coupling at a vertex of a Regge pole of integer spin J_0 and two particles whose spin projection is greater than J_0, provided the Regge pole has the wrong signature to be a particle of spin J_0. In particular, the Pomeranchuk trajectory at $t = 0$ ($J_0 = 1$) can flip helicities by two or more units and hence yield spin-dependent cross sections. Several models which support this conclusion are given. The possibility that a particular Regge pole's coupling does vanish is not ruled out, however. (auth)

42473 SPIN DEPENDENCE OF HIGH-ENERGY SCATTERING AMPLITUDES. II. ZERO-MASS PARTICLES. Mueller, A. H.; Trueman, T. L. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 160: 1306-12(Aug. 25, 1967). (BNL-11308).

The discussion of spin dependence at high energy is extended to the case of zero-mass particles. Crossing relations for zero-mass particles are derived, showing that the helicity of massless particles is simply reversed under crossing. These are used by way of a Pomeranchuk–Martin-type theorem to obtain restrictions on the high-energy spin dependence. The problem of fixed poles in the angular-momentum plane and the coupling of the Pomeranchuk trajectory to photons is discussed. It is shown that if there are no fixed poles at positive integers for any Compton amplitude, one obtains the (presumably ridiculous) result that the asymptotic total cross section for photons on any particle is proportional to the square of its charge. An approximate dynamical calculation is given which relates the coupling of photons to the Pomeranchuk trajectory with the derivative of the trajectory at $t = 0$. This yields a prediction for the high-energy total cross section of photons on protons which is consistent with present data. The convergence of the Drell–Hearn sum rule is discussed; it is argued that even with

cuts in the angular momentum, the sum rule will converge. Certain sum rules of Bég and of Pagels and Harari are discussed briefly. (auth)

42474 CONNECTION BETWEEN REGGE-POLE PARAMETERS AND LOCAL COMMUTATION RELATIONS. Rubinstein, H. R.; Veneziano, G. (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Rev., 160: 1286-93(Aug. 25, 1967).

A modification of the Fubini sum rules of current algebra is proposed. It is based upon the necessity of some amplitudes to obey subtracted dispersion relations. The proposed sum rules are studied and shown to be consistent both with the requirements of current algebra and those of Regge asymptotics. Using these results, a connection is found between Regge trajectories and the structure of the algebra. The experimental implications are discussed. Finally, high-energy quark-model results are derived by this method using Regge theory and the Gell-Mann algebra of weak currents. (auth)

42475 ANALYTICITY PROPERTIES OF HELICITY AMPLITUDES. Stapp, Henry P. (Univ. of California, Berkeley). Phys. Rev., 160: 1251-6(Aug. 25, 1967). (UCRL-11113; UCRL-17429).

The analytic structure of helicity amplitudes is derived from basic analyticity properties. Previous derivations relied on crossing properties and extra assumptions. (auth)

42476 MULTIPLE SCATTERING OF CHARGED PARTICLES, PART II. FORWARD SCATTERING APPROXIMATION. Urban, P.; Widder, F. (Univ., Graz). Oesterr. Akad. Wiss. Math.-Naturwiss. Kl., Sitzungsber., 174: 477-93(1965). (In German).

The second forward scattering approximation of an exact multiple scattering equation was compared with the Moliere theory (the first forward scattering approximation). The correction arising is so small in the total valid region of the Moliere theory 1% that one is limited to the first approximation. On this basis the Moliere theory is also valid for average scattering angles. (tr-auth).

42477 INVESTIGATION OF THE MANY-BODY, MULTI-CHANNEL PARTIAL-WAVE SCATTERING AMPLITUDE. Gross, David Jonathan. Berkeley, Calif., Univ. of California, 1966. 88p. Thesis.

An investigation of the N over D method of solving multi-channel many-body unsubtracted dispersion relations is carried out. The existence of the D-Matrix in the multi-channel many-body case is proved, thus proving that all solutions of the partial-wave dispersion relations for the amplitude are given by the N over D method. An explicit integral representation for the determinant of the multi-channel two-body D-Matrix is derived in terms of the physical eigenphase shifts and a similar representation is derived for the Fredholm determinant of a connected many-body D-operator. The CDD ambiguity is discussed and Levinson's theorem is extended to the multi-channel many-body case, and to include the possibility of extinct ghosts. The N over D equations, given by Mandelstam for three-body scattering, are used in the fixed Dalitz region approximation. Three-body scattering is discussed in detail and the generalization to n-body scattering is outlined, excluding the case where there are subenergy bound states or CDD poles. The properties of two-body eigenphase shifts are discussed. (Disser. Abstr.)

Particle Accelerators

Refer also to abstracts 41389, 41804, 41805, 42123, 42275–42277, and 42523.

42478 (BMwF-FBK-67-65) VORSCHLAG FUER EIN FFAG-ELEKTRONENSYNCHROTRON (RADIALSEKTORTYP, 150 MeV). (Proposal for a FFAG-Electron-Synchrotron (Radialsector, 150 MeV)). Heinz, W.; Hoffmann, G.; Moehl, D.; Rassow, B.; Rudloff, W. (Freie Universitaet, Berlin (West Germany). I. Physikalisches Institut). July 1967. 98p. (In German). Dep.

It is proposed to build a radial sector type FFAG-electron-synchrotron. The end energy is variable between 50 and 150 MeV. The extreme electron beam has an intensity up to 10^{-14} e^-/sec, the duty factor for the machine is variable for 10^{-4} up to 1. The accelerator gives nearly a continuous current of 10^{-5} A. It is an intensive source of γ-rays and after conversion of the electron an intensive source of positrons ($\sim 10^{-6}$ A at 100 MeV positron energy). Among others the following experiments are proposed: Investigation of the electric and magnetic structure of the nuclei by electron- and positron scattering with essentially improved duty factor, investigations of the nuclear photoeffect by the study of particle kinematics and with monoenergetic gamma rays. (auth)

42479 (BNL-11248) PRECISION SURVEYING IN RADIOACTIVE AREAS WITH TV CAMERA ON A THEODOLITE. Hopping, J. N.; Jacobus, D. D. (Brookhaven National Lab., Upton, N. Y.). [1966]. 14p. (CONF-671101-1). Dep. CFSTI.

For Presentation at Annual Meeting of the American Society of Mechanical Engineers, Pittsburgh, Pa.

Methods of precision surveying at Brookhaven Alternating-Gradient Synchrotron, necessitated by disalignment of the accelerator due to foundation drift, are described. Normal surveying methods are complicated because the area is highly radioactive. A technique employing a television camera at the eyepiece of a motorized theodolite by remote control is described. (W.H.K.)

42480 (BNL-11702) MEASUREMENT OF Q OF SUPERCONDUCTING TE_{011} CAVITIES BY FREQUENCY SWEEP TECHNIQUE. Hahn, H.; Halama, H. J.; Foster, E. H. (Brookhaven National Lab., Upton, N. Y.). [1967]. 17p. (CONF-670930-1). Dep. CFSTI.

From 6th International Conference on High Energy Accelerators, Cambridge, Mass.

A frequency sweep technique for Q measurements of superconducting cavities is described. A fast adiabatic passage through resonance shock-excites the cavity which relaxes afterwards in the form of decaying eigen oscillations. The procedure suggested permits measurements with negligible effects due to rf heating or electrical breakdown. It is suggested to use a transmission-type cavity and to measure the relaxation process of the cavity directly. The theory, which is developed in the paper, indicates that the loaded Q can be determined from the relaxation time and the coupling coefficient from the amplitude of the output signal. The frequency sweep technique has been applied to Q measurements of a superconducting TE_{011} cavity resonant at 2.868 GHz. The cavity is made of OFHC copper on which a 2.5 μm lead layer is electroplated from a lead fluoborate bath. An unloaded $Q_0 = (196 \pm 15) \times 10^6$ at 4.2°K was measured. Possible systematic errors were examined and were found to be inconsequential. The temperature dependence of Q_0 was also determined. (auth)

42481 (BNL-11703) MEASURING BETATRON FREQUENCIES IN THE BROOKHAVEN AGS. Raka, E. C. (Brookhaven National Lab., Upton, N. Y.). Aug. 4, 1967. 18p. Dep. CFSTI.

The various methods that have been used to determine the horizontal and vertical betatron wave numbers ν_x, ν_y in the AGS as a function of beam energy, position, intensity, or multipole settings are described. The results of these measurements carried out over the past several years, are presented. In addition, a qualitative description of the coupling present at high fields is given. (auth)

42482 (CERN-67-1) EFFECT OF RADIO FREQUENCY PROGRAMME NOISE ON THE STACKING PROCEDURES IN STORAGE RINGS [WITH PARTICULAR APPLICATION TO THE CERN ELECTRON STORAGE AND ACCUMULATING RING (CESAR)]. Jones, Eifionydd (European Organization for Nuclear Research, Geneva (Switzerland)). June 15, 1967. 26p. Dep.

The effect of electronic noise in the frequency program generator of the acceleration system of storage rings on the stacking procedures is studied. The Fokker-Planck equation is derived and used to deal with the effect of noisy buckets on the distribution of particles stacked in a storage ring such as CESAR. The results of an experiment with noisy buckets are shown to compare well with the diffusion model. (W.H.K.)

42483 (LA-3772) MEDIUM-ENERGY PHYSICS PROGRAM. Quarterly Status Report for the Period Ending July 31, 1967. (Los Alamos Scientific Lab., N. Mex.). Aug. 1967. Contract W-7405-eng-36. 43p. Dep. CFSTI.

The status of developments in accelerator structures, of power sources, accelerator control and instrumentation, accelerator physics, and project scheduling and facilities planning for the period ending July 31, 1967 is presented. (B.G.D.)

42484 (RPI-328-97, pp 144-53) INSTRUMENTATION DEVELOPMENT. (Rensselaer Polytechnic Inst., Troy, N. Y.).

The linac improvements, the project for increasing the number of neutron drift tubes associated with the linac, the nuclear data ADC-PDP-7 interface, and the linac computer access terminal are discussed. (B.G.D.)

42485 (UCRL-17640) MAGNETIC MEASUREMENTS OF TAMVEC, THE TEXAS A AND M UNIVERSITY 88-INCH SECTOR-FOCUSED CYCLOTRON. Kirst, Alfred; Macondray, Frederick; Nelson, Donald; Watson, Peter (California Univ., Berkeley. Lawrence Radiation Lab.). July 10, 1967. Contract W-7405-eng-48. 12p. (CONF-670705-13). Dep. CFSTI.

From 2nd International Conference on Magnet Technology, Oxford, England.

The magnetic measurements program for the new sector-focused cyclotron at Texas A & M University is described. In preliminary measurements a simple analog system was used to measure symmetry distortions in the magnetic field. The main portion of the test program employed the Lawrence Radiation Laboratory's Rapid Mapper digital data-acquisition system in which a search coil and integrator are used to measure the magnetic field. In a period of two weeks ¾ million measurements were made. The planning and preparation for these measurements and the steps in data gathering and data analysis are discussed. A cost analysis is presented. Initial results indicate that the TAMVEC magnetic field is of very good quality and compares closely to the field of the LRL 88-inch cyclotron, a near twin of TAMVEC. Features of the Rapid Mapper system which were particularly appropriate for this measuring task are discussed. They include: a peak data-logging rate of 5 measurements per second; a data resolution of less than 1 gauss; a measuring uncertainty of less than 3 gauss; extensive data-identification features; and versatile computer programs for data analysis. (auth)

42486 (UR-NSRL-2) A PULSED-BEAM FACILITY FOR THE UNIVERSITY OF ROCHESTER'S MP TANDEM. Purser, K. H.; Bahnsen, A.; Krick, M. S. (Rochester Univ., N. Y. Nuclear Structure Research Lab.). Feb. 1967. Contract AF49 (638)-1707. 93p.

The design of a pulsed beam facility for the University of Rochester's MP tandem is presented. The pulser arrangement consists of pre- and post-acceleration electrostatic beam chopping devices coupled with a bunching system. The fundamentals of pulsing and the effect of pulsing on tandem optics are discussed. (W.H.K.)

42487 (ORNL-tr-1762) SHIELDING CALCULATIONS FOR THE 300 MeV LINEAR ACCELERATOR OF DESY. Freytag, E. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Translated for Oak Ridge National Lab., Tenn., from German report D 3-1. 19p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

The sources and shielding of radiation from the 300-MeV linear accelerator of DESY are discussed. Attenuation of individual components, atmospheric calculations, and permissible radiation burden are also discussed. (W.H.K.)

42488 PULSED ACCELERATING TUBE. Abidov, M. A.; Germanskii, G. A.; Serebro, Yu. D. Nauch. Tr. Tashkent. Gos. Univ., No. 262, 87-91(1964). (In Russian).

The described 100-200 kV accelerating tube, intended to operate as a neutron generator or an ion gun, makes it possible to focus and accelerate ion currents with density up to 10 A/cm². For focusing and acceleration use is made of Pierce electrode configurations with flat insulator. The ion source is of the Penning type, and the high voltage pulse generator is a shock voltage transformer. The accelerator tube does not require complicated adjustment and is designed for stable operation in the pulsed mode. The working vacuum in the tube is 5×10^{-6} mm Hg. The simplicity of the construction and the small dimensions (the tube, together with the full vacuum pump, occupies an area of 180-70 cm²) make it suitable for school laboratories. (ATD)

42489 DYNAMIC MEASUREMENTS OF LOW MAGNETIC FIELDS WITH SPECIAL REFERENCE TO THE STRONG FOCUSING 1.2-GeV ELECTRON SYNCHROTRON AT LUND. Nysaeter, Hans (Royal Inst. of Tech., Stockholm). Trans. Roy. Inst. Technol., Stockholm, No. 174, 30p(1961).

Problems concerned with detailed measurement and eventual correction of the injection field of a strong-focusing electron synchrotron are discussed. Accuracy of relative field measurements at any time during the accelerating cycle had to be within 0.1% and the radial gradient of the vertical guiding field relative to the field level (the n-value) had to be measured to better than 1%. This could be achieved at high and intermediate fields with comparative methods, integrating signals from stationary search coils. At the start of the accelerating cycle, however, the sensitivity from the integrated signals became insufficient. Another approach was attempted for measuring the injection field of about 5×10^{-3} Wb/m², the behavior of which was of vital importance to the performance of the synchrotron and at which level the magnetic field pattern was disturbed in an unpredictable way by remanent field and eddy current effects. Since no measuring methods at the injection field level and with the desired accuracy were reported an investigation was initiated on so-called peaking strips. A general description of peaking strips is given, as well as an account for their use in the measuring methods developed, and some of the results obtained with the described methods applied to the 1.2-GeV strong focusing electron synchrotron. With the method employing peaking strips developed for measuring low magnetic fields (up to 2×10^{-2} Wb/m²) with high accuracy, it was possible to obtain the injection time behavior of the magnetic field of the synchrotron. For the strips employed, the thinnest available wire of the most promising core material was chosen, namely 4-79 Mo-Permalloy drawn to a dia of 0.002 cm. The wire annealed in hydrogen at 1100°C for half an hour and subsequently cooled to room temperature in another half an hour. After careful selection, it was possible to obtain strips as short as 0.7 cm with a pulse width at half amplitude corresponding to 2×10^{-5} Wb/m² for a time derivative of the magnetizing field of 6×10^{6} A/m·s (the value valid at injection time for the electron synchrotron). (auth)

42490 ELECTRON BEAM INSTABILITY AND ISODOSE ASYMMETRY ASSOCIATED WITH A 35 MeV MEDICAL BETATRON. Robinson, J. E.; McDougall, R. S. (Univ. of Maryland, Baltimore). Phys. Med. Biol., 12: 315-20(July 1967).

Initial dosimetry measurements on a Brown-Boveri 35 MeV betatron indicated poor reproducibility of electron beam isodose curves. An investigation showed that the beam position and shape depended strongly upon a given combination of electron energy and extraction voltage. Small changes in extraction voltages or small drifts in energy produced large asymmetries in the radiation field. Under normal operating conditions the asymmetries were large enough to present serious clinical problems. A special device subsequently developed by the manufacturers has eliminated these difficulties. In order to monitor beam symmetry two cylindrical ionization chambers were mounted in the fringe of the radiation field. The output of these chambers was fed subtractively to a voltmeter located on the control console, symmetry being indicated by a voltage null. An auxiliary extraction-voltage control was incorporated in the system and symmetry was maintained by a manual adjustment of this control. (auth) (UK)

42491 THEORETICAL CONSIDERATIONS ON THE ELECTRON OPTICS OF A RING-BEAM ELECTRON GUN. Bas, E. B.; Gaug, H. (Eidgenossische Technische Hochschule, Zurich). Z. Angew. Math. Phys., 18: 557-74(July 25, 1967). (In German).

A ring beam electron gun consists of a circular cathode and of focusing and accelerating electrodes arranged concentrically in such a way that the electrons can be accelerated towards the center of curvature of the ring-cathode. In this system the electron beam is brought to a focus in the center of the gun in the plane of the circular cathode by cathode curvature, while in the perpendicular direction focusing is obtained by the geometry of the focusing electrodes. When the cathode is heated by a direct current the magnetic field of this circular current deflects the electron paths in the symmetry plane of the gun (plane of the ring-cathode) in such a manner that, neglecting the electron gas temperature, no electrons can reach a circular area of certain radius in the center of the gun. The radius of this dead zone is calculated as a function of the relevant gun parameters according to the laminar theory and then the definition of the dead zone is modified with respect to the Maxwellian distribution of electron velocities and also for heating of the ring-cathode with ac. If a second circular current concentric with the circular current of the cathode but flowing in the opposite direction is introduced, one can completely eliminate the electron deflection effect in the central part of the gun. The influence of this compensation current is calculated and represented in graphical form. Also some calculations of achievable current densities on a cylindrical object in the center of the gun are reported both for compensated and partly compensated cases. (auth)

42492 A LINE OF RESEARCH FOR ADONE, THE ITALIAN ELECTRON-POSITRON COLLIDING BEAM MACHINE. Amaldi, Ugo Jr. (Istituto Superiore di Sanita, Rome). Ann. Ist. Super. Sanita, 2: 799-810(1966). (In Italian).

The electron–positron storage ring Adone is describe, and a line of research is proposed. A study of the ϕ resonance for the determination of the γ-ϕ coupling constant through the measurement of K^+K^- pairs is proposed. A study of the limits that $e^+ + e^- \rightarrow e^+ + e^-$, $e^+ + e^- \rightarrow \gamma + \gamma$, and $e^+ + e^- \rightarrow \mu^+ + \mu^-$ impose on the distance λ, which can be interpreted as the distance at which the inverse square dependence upon the distance of the Coulomb law remains valid is proposed. A study of a possible experiment of elastic scattering $e^+ + e^- \rightarrow e^+ + e^-$ with recognition of the final charges is made. (W.H.K.)

42493 ON THE DESIGNING OF CYCLOTRONS, SPECIALLY OF MULTI-ω-TYPE. Boettger, O.; Wolff, W. (AEG-Forschungsinstitut, Frankfurt am Main). Atomkernenergie, 12: 298-302 (1967). (In German).

Considering various requirements of the user, design of a cyclotron is described, incorporating their demands. (auth)

42494 X-BAND ELECTRON LINEAR ACCELERATOR. Fukumoto, Sadayoshi; Mizumachi, Yoshihiko (Tokyo Univ.). Oyo Butsuri, 36: 19-30(Jan. 1967). (In Japanese).

A 2-MeV electron accelerator of $\pi/2$ mode travelling wave

type was designed and constructed. The accelerating microwave frequency is 8976 Mc/s. The rf structure of the S-band MARK-IV accelerator at Stanford University (2856 Mc/s) is scaled down to X-band. In order to comply with the decrease of the electric field strength, several additional cavities are interposed in the buncher section. The rf power of 200 kW is supplied by a frequency-tunable magnetron. The injection energy of electrons is 185 keV. The rf phase velocity increases from 0.6556 c to 0.9400 c in the buncher, and stays at 0.96 c in the regular section. The electron energy obtained is 1.8 MeV with output current of 10 mA, pulse length 2 μsec, and pulse repetition rate 50, 100, and 200 ppS. (auth) (NSA of Japan)

42495 COLLISION RINGS: A.C.O. AS EXAMPLE. Geoffrion, B. (Laboratoire Joliot-Curie de Physique Nucleaire, Orsay, France). Ann. Phys. (Paris)(14), 2: 9-15(Jan.-Feb. 1967). (In French).

The special problems proposed by collision rings are discussed using the Orsay Collision Ring as an example. The synchrotron radiation, the ion effect, and the lifetime of the beam are discussed. (J.S.R.)

42496 PULSE ACCELERATING TUBE. Abidov, M. A.; Gumanskii, G. A.; Serebro, Yu. D. Nauch. Tr. Tashkent. Gos. Univ., No. 262, 87-91(1964). (In Russian).

A 100 – 200 kV accelerating tube is described which accelerates and focuses ion beams with an intensity of 100 A/cm^2. A Penning source was used as the ion source and an impact potential transformer was used as the high-voltage pulse generator. (B.G.D.)

42497 HIGH-INTENSITY 25-MeV BETATRON. Vorob'ev, A. A.; Moskalev, V. A.; Skvortsov, Yu. M.; Okulov, B. V.; Slupskii, A. M.; Shestakov, V. G. (Tomsk Order of Labor Red Banner Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 4, 139-40(1967). (In Russian).

The improvements by means of which the radiation intensity delivered by the 25-Mev betatron of the Tomsk Polytechnic Institute was increased beyond the 1000 r/min. m. level are described. These improvements include extensive modernization of the magnet, greater cooling of the ejection system, and the addition of an autotransformer unit for smoother start and power regulation. Much attention is given to the difficulties experienced with dose measurements. The measured intensities were found to exceed the range of usual roentgenometers, and for this reason qualitative evaluations were made by x-raying metal samples (up to 510 mm thick) with the radiation from the betatron, and on the basis of the radioactivity induced in copper by this radiation. (ATD)

42498 NINA: THE 4 GeV ELECTRON SYNCHROTRON OF THE SCIENCE RESEARCH COUNCIL. Merrison, A. W. (Univ. of Liverpool). Contemp. Phys., 8: 373-84(July 1967).

In December of last year the 4000-Mev electron accelerator of the Science Research Council's Daresbury Laboratory was brought into operation. An account of the physics underlying the design of such an accelerator and a brief description of the physical problems which will be studied with it are given. (auth)

42499 A SPRAY CURRENT REGULATING SYSTEM FOR SLOW VOLTAGE-STABILIZATION OF VAN DE GRAAFF GENERATOR. Kadar, Imre (KLTE, Debrecen, Hungary); Koltay, Ede; Somorjai, Endre; Szegedi, Sandor. ATOMKI (At. Kut. Intez.) Kozlem., 9: 99-104(June 1967). (In Hungarian).

A spray current stabilizer system and a generating voltmeter of reference field were combined in order that the change of the stabilized spray current should continually follow the slow change of the loading currents of generator. So the generator voltage is kept at constant value, except for the fast voltage fluctuations resulting from fast changes of loading currents. In this manner ±0.3% voltage stability of the KLTE-KFI Van de Graaff generator was achieved. The voltage instabilities were determined by measuring the oscillations of beam position in the image plane of the magnetic analyzer of the generator. The voltage stability can be further increased with the aid of a parallel fast regulating system. (auth)

42500 HIGHEST-FLUX NEUTRON SOURCES. II. USES, DEVELOPMENT TENDENCIES, ADVANTAGES, AND LIMITATIONS. Beckurts, K. H. Atomwirt. Atomtech., 12: 357-62(July 1967). (In German).

Rapid progress in the application of neutron beams in research has resulted in a considerable development of neutron sources. The most important of such sources are today the high flux reactor, the pulsed reactor resp. neutron amplifier and the high energy accelerator. While neutron fluxes of about 10^{11}n/cm^{2}sec were reached in the first research reactors high flux reactors today attain levels of 10^{15} and neutron production rates as high as 10^{18} are provided for short times by accelerators. In addition to the production of transuranium elements application possibilities for high neutron intensities exist in various research lines in nuclear physics and solid state physics, e.g., for the investigation of the basic properties of free neutrons, the nuclear reactions of fast neutrons, the dynamic properties of condensed matter, for the measurement of cross-sections, for nuclear fission, for capture gamma radiation, for the structure analysis by neutron diffraction, etc. Details are given of existing or projected examples of the various kinds of neutron sources: high flux reactors: the Savannah River High Flux Demonstration, the HFIR, the AARR, the SM-2 and the Grenoble reactor; pulsed reactors: the IBR, the SORA and the APR; accelerators: the ING. All systems have their own special characteristics, advantages and disadvantages which are also discussed in detail from financial and commercial points of view. The long term prospects for the various systems may be summarised as follows. Today only the high flux reactors have attained sufficient technical maturity. Their development is however already approaching the practical limits and greater efforts to attain higher neutron fluxes will at best perhaps only be undertaken for the special projects involving the production of transuranium elements. Pulsed reactors are only at the beginning of their development. Only when the SORA project becomes a reality will there be an installation in existence whose results are comparable with a high flux reactor. It is true that very advanced pulse reactors could far exceed the performance of high flux reactors in limited areas. A neutron source consisting of a high energy accelerator of the type of the Intense Neutron Generator (ING) could surpass both reactor varieties in respect of output. However because of the high cost there will always be few installations of this kind; indeed it is at the moment doubtful whether or not one will be built. Still other possibilities are of interest in the long term, e.g., nuclear explosions, which have already attained considerable interest in the USA for neutron time of flight spectroscopy, or the use of large quantities of spontaneously fissioning transuranium elements. Thermonuclear fusion also opens further basic possibilities. The development of high flux neutron sources on the other hand provides nuclear technology with an attractive spur, e.g., for the building of power reactors with very high power densities. (auth)

42501 NEW PROTON ACCELERATOR. Mints, A. L. Vestn. Akad. Nauk SSSR, No. 6, 52-3(June 1967). (In Russian).

A brief description is given of a 7-GeV proton accelerator recently put into operation at the Institute of Theoretical and Experimental Physics. With the accelerated proton energy of 25 MeV the current reached was 135 mA. (R.V.J.)

42502 POLARIZED TARGETS AND ION SOURCES. Proceedings of the International Conference, Saclay, France, December 5–9, 1966. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, [1967]. 410p. (CONF-661205).

Twenty-eight complete papers are included. Separate abstracts were prepared for 24 of the papers. The remaining 4 papers previously appeared in NSA as 21: 5066, 13713, 23308, and 25424.(C.E.S.)

For abstracts of individual papers see: 41974, 42259, 42370–42372, 42461, 42503–42518, 42531, and 42532.

42503 POLARIZED TARGETS: WHY. Jackson, J. D. (Univ. of Illinois, Urbana). pp 3-26 of Polarized Targets and Ion Sources. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, [1967].

From Conference on Polarized Targets and Sources, Saclay, France, Dec. 5–9, 1966. See CONF-661205.

It is pointed out that additional information on scattering amplitudes beyond that obtainable from the cross section alone may be gained by using polarized targets. Examples of the uses of polarized targets discussed are: intrinsic parity determination, spins and parities of resonant states, polarization at high energies, polarization in nucleon-nucleon scattering, vector meson production from a polarized target, and test of time-reversal invariance in electromagnetic interactions. (W.H.K.)

42504 POLARIZED TARGETS: HOW? Abragam, A. (CEN, Saclay, France). pp 27-39 of Polarized Targets and Ion Sources. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, [1967].

From Conference on Polarized Targets and Sources, Saclay, France, Dec. 5–9, 1966. See CONF-661205.

Methods for nuclear polarization are discussed including increase of the H/T ratio and dynamical methods in the conventional range of magnetic field H and temperature T. The dynamical methods are the Overhauser effect and the solid effect. The solid effect is the only method that has had experimental success and is accomplished by subjecting a diamagnetic material containing paramagnetic impurities to a microwave magnetic field so that the nuclear spin orientations occur at a rate greater than the nuclear relaxation time. Two essential conditions are narrow electron resonance and short electronic relaxation time. (W.H.K.)

42505 TECHNOLOGY OF PRESENT HIGH ENERGY TARGETS. Atkinson, H. H. (Rutherford High Energy Lab., Chilton, Eng.). pp 41-93 of Polarized Targets and Ion Sources. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, [1967].

From Conference on Polarized Targets and Sources, Saclay, France, Dec. 5-9, 1966. See CONF-661205.

The technological aspects of the construction, operation, and measurement of polarization of polarized proton targets are discussed. Considerations on target material, magnetic field, cryogenic system, microwave system, and NMR measurement are included. (W.H.K.)

42506 COMMENT ON PROTON RELAXATION IN Nd:LaMN AT HIGH FIELDS AND LOW TEMPERATURES. Jeffries, C. D. (Univ. of California, Berkeley). pp 95-6 of Polarized Targets and Ion Sources. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, [1967].

From Conference on Polarized Targets and Sources, Saclay, France, Dec. 5-9, 1966. See CONF-661205.

Measurements were made on the proton spin lattice relaxation rate T_{1P}^{-1} in a crystal of Nd:LaMN, grown from a 1% solution, with $Z \perp H$ over the ranges $10 < H < 50$ kOe and $0.5 < T < 3$°K using a superconducting solenoid and a ^{3}He cryostat. The results agree with predictions from the shell-of-influence model and show that very long relaxation times may be achieved. From the measured value $T_{1P} = 40$ hours in 19.5 kOe at 0.5°K, it is predicted T_{1P} = several thousand hours at 0.3°K. (W.H.K.)

42507 THEORETICAL ASPECTS OF NUCLEAR DYNAMIC POLARIZATION. Borghini, M. (CERN, Geneva). pp 133-46 of Polarized Targets and Ion Sources. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, [1967].

From Conference on Polarized Targets and Sources, Saclay, France, Dec. 5-9, 1966. See CONF-661205.

Details of the theory of nuclear dynamic polarization by the solid effect are presented. Reasons why the solid effect does not work in every case and suggestions for improvement of the present achievements are specified. (W.H.K.)

42508 THEORY AND OPERATION OF NUCLEAR SPIN REFRIGERATORS. Jeffries, C. D. (Univ. of California, Berkeley). pp 147-67 of Polarized Targets and Ion Sources. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, [1967].

From Conference on Polarized Targets and Sources, Saclay, France, Dec. 5-9, 1966. See CONF-661205.

Preparation of nuclear polarized targets using a nuclear spin refrigerator is discussed. The crystal used is ytterbium yttrium ethyl sulfate $(Yb,Y)(C_2H_5SO_4)_3 \cdot 9H_2O$ containing ~1% paramagnetic Yb^{3+} ions. A comparison of the proton polarization, advantages, and disadvantages using spin refrigerators is made with those achieved by microwave dynamic polarization. (W.H.K.)

42509 POLARIZED ION SOURCES. Beurtey, R. (CEN, Saclay, France). pp 177-90 of Polarized Targets and Ion Sources. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, [1967].

From Conference on Polarized Targets and Sources, Saclay, France, Dec. 5-9, 1966. See CONF-661205.

Polarized ion sources following the conventional atomic beam method, with a Stern-Gerlach separation followed by rf transitions are compared to more recent polarized ion sources that are produced by two near-resonant charge transfer processes via the (2S) state of atomic hydrogen. Related developments at various laboratories are also discussed. (W.H.K.)

42510 SOME GENERAL PROBLEMS IN PRODUCING DENSE POLARIZED ^{3}He TARGETS. Carver, T. R. (Princeton Univ., N. J.). pp 191-9 of Polarized Targets and Ion Sources. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, [1967].

From Conference on Polarized Targets and Sources, Saclay, France, Dec. 5-9, 1966. See CONF-661205.

The preparation of a dense gaseous or liquid ^{3}He polarized target suitable for high energy scattering is considered. Approaches such as brute force polarization, dynamical polarization, and optical pumping are presented. The possibility that discharges in gaseous ^{3}He might lead to dynamic polarization effects and the effect of relaxation by field inhomogeneities in gaseous ^{3}He are also discussed. (W.H.K.)

42511 SOURCE OF POLARIZED ELECTRONS PRODUCED BY IONIZATION OF A BEAM OF ORIENTED POTASSIUM ATOMS. Coiffet, P.; Septier, A. (Faculte des Sciences, Orsay, France). pp 229-33 of Polarized Targets and Ion Sources. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, [1967]. (In French).

From Conference on Polarized Targets and Sources, Saclay, France, Dec. 5-9, 1966. See CONF-661205.

In the electron source described atomic potassium is omitted from a furnace at a temperature of 300°C. The atomic beam then crosses a very strong inhomogeneous magnetic field. Thus spin-$\frac{1}{2}$ atoms are selected; these are focused out of the magnet. The atoms are now in a longitudinal magnetic field and ionized by ultraviolet radiation. The electrons thus obtained are polarized, the ionization taking place without transition. They are accelerated. After transformation of their helicity by transverse polarization by means of a Wein filter, their polarization is measured by Mott scattering. The design and performance of the polarized atom source are also presented. (J.F.P.)

42512 DESCRIPTION OF LOW ENERGY TARGETS. Garreta, D. (CEN, Saclay, France). pp 283-95 of Polarized Targets and Ion Sources. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, [1967].

From Conference on Polarized Targets and Sources, Saclay, France, Dec. 5-9, 1966. See CONF-661205.

A report on the present situation in the field of polarized proton targets used in low energy physics is presented. The specific problems encountered in their design, a description of three targets already built and used in nuclear physics experiments, and a description of targets that are planned to be built are discussed. (W.H.K.)

42513 EFFECTS OF RADIATION DAMAGE ON PROTON RELAXATION TIME IN LANTHANUM MAGNESIUM DOUBLE NITRATE. Hardy, W. N.; Shapiro, G. (CEN, Saclay, France). pp 367-71 of Polarized Targets and Ion Sources. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, [1967].

From Conference on Polarized Targets and Sources, Saclay, France, Dec. 5-9, 1966. See CONF-661205.

An investigation is described which attempts to place more exact figures on the radiation flux required to change the NMR characteristics of lanthanum magnesium double nitrate (LMN), $La_2Mg_3(NO_3)_{12} \cdot 24H_2O$ with about 1% doping of neodymium. An attempt to determine whether the damage done by electrons, which have low specific ionization and small nuclear cross sections, might be less than that of slow protons is also described. The procedure consisted of immersing an LMN crystal in liquid helium at 1.2°K in close proximity to a source of strontium-90 and in an external magnetic field of 7000 gauss. The proton relaxation time was measured by NMR techniques. (W.H.K.)

42514 LIVERPOOL POLARIZED PROTON TARGET. Hayman, P. J. (Liverpool Target Group). pp 373-6 of Polarized Targets and Ion Sources. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, [1967].

From Conference on Polarized Targets and Sources, Saclay, France, Dec. 5-9, 1966. See CONF-661205.

The general assembly of the Liverpool polarized proton target is described. The design of the coils used to generate the magnetic field and the determination of the useful volume of the uniform field are discussed. (W.H.K.)

42515 ATTEMPT TO IDENTIFY THE PHYSICAL MECHANISM OF RADIATION DAMAGE. Hayman, P. J. (Liverpool Target Group). pp 377-9 of Polarized Targets and Ion Sources. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, [1967].

From Conference on Polarized Targets and Sources, Saclay, France, Dec. 5-9, 1966. See CONF-661205.

An attempt is made to explain the physical mechanism of radiation damage which causes reduction in polarization in polarized targets. Data are given, and a brief theoretical approach to the problem is presented. (W.H.K.)

42516 RECENT RESULTS ON PROTON POLARIZATION IN SEVERAL HYDROCARBONS. Haddock, R. P.; Wagner, R. J. (Univ. of California, Los Angeles). pp 381-5 of Polarized Targets and Ion Sources. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, [1967].

From Conference on Polarized Targets and Sources, Saclay, France, Dec. 5-9, 1966. See CONF-661205.

Experiments in which the protons in solid toluene and several other similar hydrocarbons have been polarized by the solid state effect are discussed. The hydrocarbons are doped with a small amount of the stable free radical diphenyl picrylhydrazil (DPPH), and the polarization enhancements are observed as a function of concentration and temperature. All observations were made using magnetic fields of 20.4 kG and microwave frequencies near 57 GHz in a temperature range of 4.2°K to near 1°K. (W.H.K.)

42517 SIZEABLE PROTON POLARIZATIONS IN FROZEN ALCOHOL MIXTURES. Borghini, M.; Mango, S.; Runolfsson, O.; Vermeulen, J. (CERN, Geneva). pp 387-91 of Polarized

Targets and Ion Sources. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, [1967].

From Conference on Polarized Targets and Sources, Saclay, France, Dec. 5–9, 1966. See CONF-661205.

Preliminary results of an investigation of high proton polarizations in highly hydrogenated substances such as ethanol-water, ethanol-methanol, and ethanol-propanol mixtures doped with various free radicals are presented. The method of polarization is the solid effect. The polarization is measured by NMR. (W.H.K.)

42518 MEASUREMENTS OF THE POLARIZATION AND ITS REVERSAL BY FAST PASSAGE. Chapellier, M. (CEN, Saclay, France). pp 393–4 of Polarized Targets and Ion Sources. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, [1967].

From Conference on Polarized Targets and Sources, Saclay, France, Dec. 5–9, 1966. See CONF-661205.

Three methods of measuring the polarization other than comparison of the NMR enhanced signal with a signal obtained at thermal equilibrium are presented. Polarization reversal by adiabatic fast passage is also discussed. (W.H.K.)

42519 HIGH ENERGY CHARGED PARTICLE GENERATOR. (to Varian Associates). British Patent 1,082,940. Sept. 13, 1967. Priority date June 30, 1964, United States.

A high-energy positron generator which comprises an electron linear accelerator and a high Z target is described. (B.G.D.)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 41292, 41809, 42500, 42634, 42638, and 42762.

42520 (BNL–50061B) SIGMA CENTER, NEUTRON CROSS SECTION COMPILATION CENTER SCISRS NEWSLETTER. PART B. ISOTOPE LISTING. (Brookhaven National Lab., Upton, N. Y.). June 1967. 107p. Dep. CFSTI.

A listing, arranged by isotope, is given of references to published and other material on various neutron cross sections. The cross-section types, dates of publication, and neutron energy ranges are included. The listing comprises the major part of the data contained in the Sigma Center Storage and Retrieval System (SCISRS) to date. (S.F.L.)

42521 (BNWL–345) SOME MEASUREMENTS OF THE NEUTRON SCATTERING LAW FOR LIGHT WATER AT 95°C. Smith, Robert B. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug. 1967. Contract AT(45-1)-1830. 47p. Dep. CFSTI.

Measurements were made of the double-differential scattering of slow neutrons from H_2O at 95°C using a triple-axis spectrometer. Scattering cross-section values were obtained by normalization to the measured scattering from vanadium and were further reduced to the Egelstaff scattering law presentation. With initial energy values from 100 to 377 MeV, results were obtained for neutron energy changes of 40 to 175 MeV and scattering angles of 4 to 70°. During the course of these measurements several sources of systematic errors in triple-axis spectrometer measurements were investigated. These include the effect of spatial nonuniformities in the neutron beam intensity and in analyzer sensitivity as well as multiple diffraction in beryllium monochromator crystals [simulated (0003) reflections were noted]. The magnitudes of these effects and methods of minimizing their contributions are discussed. Also described is a copper monochromator crystal in which mosaic was increased by mechanical deformation. (auth)

42522 (NAA-SR–12509(Vol,1)) TRIX-2: AN ADVANCED ANALYTIC CALCULATION OF RESONANCE INTEGRALS AND DOPPLER COEFFICIENTS. PART 1. THEORY. Otter, J. M. (Atomics International, Canoga Park, Calif.). Sept. 15, 1967. Contract AT(04-3)-701. 47p. Dep. CFSTI.

The theory underlying the calculations in the TRIX-2 code is described, and the equations used are given, together with the tabular data utilized. A new technique for removing the flat flux approximation for lumped absorbers in an efficient, convenient manner is also described. The code provides calculations of self-shielding of low-energy cross sections, Dancoff shadowing in lattices, fission widths from channel fission theory, and adjustments to well-known experimental controls, as well as intermediate scattering of all elements. These features give the code the capability of providing, in a single calculation, multigroup resonance integrals and Doppler coefficients for most reactor designs. (auth)

42523 (RPI–328–97) LINEAR ACCELERATOR PROJECT. Progress Report, April–June 1967. (Rensselaer Polytechnic Inst., Troy, N. Y.). Contract AT(30-3)-328. 153p. Dep. CFSTI.

Separate abstracts were prepared for the five sections of the report. (D.C.W.)

For abstracts of individual sections see: 42484, 42524–42526, and 42615.

42524 (RPI–328–97, pp 35–95) FAST REACTOR PHYSICS. (Rensselaer Polytechnic Inst., Troy, N. Y.).

Position-dependent spectra were measured in iron and depleted uranium assemblies, and Pb and Pb–Ta targets for electron-beam neutron sources were investigated. Detectors for neutron time-of-flight spectrometry in the upper keV range were studied including a ^{10}B–NaI detector and the correction of time-of-flight data for the energy-dependent relative efficiency of the detectors used. Methods for calculating fast neutron spectra in assemblies under conditions that are suitable for comparison with measurements were developed as was a generalized formulation of reactor kinetic equations. (D.C.W.)

42525 (RPI–328–97, pp 96–130) NEUTRON THERMALIZATION. (Rensselaer Polytechnic Inst., Troy, N. Y.).

The study of time moments for diffusion and transport theory was extended to slab geometry. The recurrence relation for the nth time moment was obtained in terms of the (n-1)th time moment. (D.C.W.)

42526 (RPI–328–97, pp 131–43) LOW ENERGY NEUTRON INELASTIC SCATTERING (LENIS). (Rensselaer Polytechnic Inst., Troy, N. Y.).

The calculation of time-dependent thermal neutron spectra in finite media was continued with emphasis on calculating the scattering kernels using the FLANGE and GASKET scattering law codes. The Doppler broadening of neutron resonances in a bound nucleus was studied; analyses of resonance cross sections and integral parameters were performed together with numerical calculations. (D.C.W.)

42527 METHODS FOR COLLAPSING FAST-REACTOR NEUTRON CROSS SECTIONS. Little, W. W. Jr.; Hardie, R. W. (Battelle-Northwest, Richland, Wash.). Nucl. Sci. Eng., 29: 402–7(Sept. 1967).

A description is given of two methods for collapsing many-group cross sections to few-group cross sections. The analysis is applicable to intermediate and large-volume fast reactors. It is shown that the simple flux weighting collapsing recipe, with reciprocal weighting of the transport cross section, is adequate for computing reaction rates, k_{eff}, etc., but is inadequate for computing moderator reactivity coefficients. A collapsing algorithm is developed which permits an accurate calculation of moderator reactivity coefficients using few-group cross sections. (auth)

42528 A SOLUTION OF THE CORNGOLD EQUATION: RESULTING THERMAL-NEUTRON SPECTRA AND CONSTANTS. Sims, Ernest Park; Bridgman, Charles J. (Air Force Inst. of Tech., Dayton, Ohio). Nucl. Sci. Eng., 29: 455–8(Sept. 1967).

A solution of the Corngold equation is presented together with some numerically computed spectra. It is shown that the more easily solved Wilkins' equation is adequate for most calculations. (D.C.W.)

42529 WIELANDT'S METHOD APPLIED TO THE TIME INDEPENDENT NEUTRON DIFFUSION DIFFERENCE EQUATIONS. Noda, Takashi (Hitachi Ltd., Tokyo). Joho Shori, 7: 84–90 (Mar. 1966). (In Japanese).

In the application of the Wielandt's method to the 2-dimensional neutron diffusion difference equations, $(M - 1/\lambda_\rho F)\vec{\phi} = (1/\lambda - 1/\lambda_\rho) F\vec{\phi}$, studies are made on the convergence of the Wielandt's method with $\lambda_\rho = \lambda^{(k)}$ where k is the outer iteration number, the applications of Gaussian elimination to the equation $(M - 1/\lambda_\rho F)\vec{\phi} = \vec{d}$, and the properties of the matrix $M^{-1}Q$ when the diagonal matrix Q is defined as $Q\vec{\phi}_1 = F\vec{\phi}_1$ and $M\vec{\phi}_1 = 1/\lambda_1 F\vec{\phi}_1$. (NSA of Japan)

42530 SOLUTION OF THE (n,n',γ) TRANSPORT PROBLEM IN CARBON: MONTE CARLO. Lawson, B. L.; Cook, C. F. (Phillips Petroleum Co., Bartlesville, Okla.). J. Nucl. Energy, 21: 653–69(Aug. 1967).

The Monte Carlo technique was applied to the determination of the steady-state and time-distribution of the unscattered 4.43-MeV γ flux arising from multiple inelastic scattering of neutrons with carbon nuclei in an infinite graphite medium. The neutrons emanate from a 14-MeV isotropic point source. The computer program requires 0.85 min per thousand histories with 5000 histories more than sufficient to obtain significant answers. The steady-state single and multiple inelastic neutron produced unscattered γ flux can be approximated by a simple formula of the form $\phi_{ss} = Ae^{-\mu r}_m / 4\pi r^2_m$, where μ is the γ absorption coefficient of 4.43-MeV γ rays in carbon, r_m is the source-detector separation distance, and A is a pseudo-source strength. Time-distribution studies reveal that the peak intensity of the 4.43-MeV γ flux following a neutron pulse of zero time width monotonically increases from 2 to 5 nsec as the source-detector separation increases from 10 to 80 cm. This unscattered γ flux decreases by a factor of 100 in the next 10 nsec with an exponential character. (auth) (UK)

42531 POLARIZED NUCLEI AND NEUTRONS. Shapiro, F. L. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 339–56 of Polarized Targets and Ion Sources. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, [1967].

From Conference on Polarized Targets and Sources, Saclay, France, Dec. 5–9, 1966. See CONF-661205.

A discussion of some possibilities of using polarized nuclear targets in neutron physics is given. The work performed in Dubna using a dynamically polarized proton target to obtain a polarized beam of neutrons is discussed. Experiments with this beam and with a polarized deuteron target, where the spin dependence of n-d scattering was studied, and experiments with a polarized target of

^{165}Ho, where the spins of a number of neutron resonances of holmium were determined, are also discussed. (W.H.K.)

42532 POLARIZED TARGETS AND NEUTRONS. Schermer, R. I. (Brookhaven National Lab., Upton, N. Y.). pp 357-66 of Polarized Targets and Ion Sources. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, [1967].

From Conference on Polarized Targets and Sources, Saclay, France, Dec. 5-9, 1966. See CONF-661205.

The advantages and techniques of experiments involving the transmission of polarized neutrons through polarized targets are discussed. An idea of the range of problems which may be attacked by studying this transmission is given. (W.H.K.)

42533 NOTE ON THE GENERALIZED ENDPOINT METHOD. Thielheim, K. O. (Univ., Kiel). Atomkernenergie, 12: 327-30 (1967). (In German).

The boundary value of the generalized endpoint method has been tabulated in terms of the material constant for various angular distributions. The relation between the generalized endpoint method and the albedo problem is considered. Explicit expressions are given for the albedo for various angular distributions. (auth)

42534 EQUILIBRIUM DISTRIBUTION OF THE THERMAL NEUTRONS. Meyer, K. (VEB Atomkraftwerk Rheinsberg, Berlin). Kernenergie, 10: 181-3 (June 1967). (In German).

Using the thermodynamic Greens function method, the equilibrium distirbution of the thermal neutrons in an infinite homogeneous non-absorbing source-free medium is investigated. In the second approximation, the equilibrium distribution is found to be independent of the interaction between neutrons and the moderator nuclei. (auth)

42535 BEHAVIOR OF THE NEUTRON GAS IN FINITE MEDIA. Purica, I. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 12: 87-93 (1967).

A synthesis of the research works on the behavior of the neutron gas in different media is presented. A brief analysis of various models employed for solving the Boltzmann equation is made. Further, the research carried out at the VVR-S reactor for studying the neutron spectrum by means of stationary and dynamic methods is discussed. (auth)

42536 NEUTRON FLUX VARIATION OF THE AXIS OF A 14 MeV NEUTRON GENERATOR. Darrall, K. G.; Oldham, G. (Loughborough Univ. of Tech., Eng.). Nucl. Energy, 104-5 (July-Aug. 1967).

Flux variations were measured at axial distances up to 4 in. from the tritium target using molybdenum, oxygen, copper, antimony, and fluorine, which have thresholds in the range 6 to 13 MeV. The results are compared with calculations based on a method used by Bonazzola. While good agreement was found, there were indications of a small attenuation of energy. Cadmium/indium foil measurements showed neutrons up to 1.5 eV to constitute 0.1% of the fast flux. (UK)

42537 ON THE EXISTENCE OF THE FUNDAMENTAL MODE OF THE NEUTRON TRANSPORT OPERATOR IN A SPHERICAL ASSEMBLY. Ghatak, A. K. (Indian Inst. of Tech., New Delhi). J. Nucl. Energy, 21: 509-15 (June 1967).

The results of some calculations on the existence of a fundamental discrete mode of the neutron transport operator in a spherical medium are reported. This mode represents the asymptotic exponential decay of a thermal neutron distribution following a neutron burst. It is known that such a discrete mode does not exist for a sufficiently small medium and that the fundamental mode decay constant can not be less than $-\nu \lim_{\nu \to 0} [\nu\Sigma(\nu)]$ where ν is the neutron velocity and Σ is the corresponding total cross section. It is shown that if the energy domain is bounded away from zero, the discrete eigenvalue exists for any radius of a sphere; and for $\lambda < -(\nu\Sigma)_{min}$ the eigenvalue can be made to lie arbitrarily close to $-(\nu\Sigma)_{min}$ by choosing an appropriately small cut-off energy. It is the latter fact which is important, and which brings out explicitly the importance of $(\nu\Sigma)_{min}$ in the approach to equilibrium even in bounded media. Although the present calculations are based on a simple thermalization model with a separable scattering kernel, the main conclusions are expected to be valid for any realistic model in any bounded geometry. (auth) (UK)

42538 SCATTERING RESONANCE SELF-SHIELDING CORRECTION FOR USE WITH MANGANESE SULPHATE SOLUTIONS. Axton, E. J.; Ryves, T. B. (National Physical Lab., Teddington, Eng.). J. Nucl. Energy, 21: 543-6 (July 1967).

The resonance neutron absorption in aqueous manganese sulphate solution was calculated from slowing-down theory, and is compared with other published results. The values were applied to the measurement of neutron source strength by the manganese bath technique, and the resulting error in source strength found to be ± 0.1%, assuming a manganese resonance integral of 8.0 ± 0.8 barns. (auth) (UK)

42539 DISCONTINUITIES IN THE THERMAL NEUTRON SPECTRA OF CRYSTALLINE MODERATORS. Williams, M. M. R. (Queen Mary Coll., London). J. Nucl. Energy, 21: 581-2 (July 1967).

A formula is presented for the ratio of the flux values just below and just above any discontinuity. It is suggested that the formula will be of value in assessing the accuracy of numerical techniques, and also for direct calculation of diffusion coefficients at the various Bragg energies. (UK)

42540 ENERGY-DEPENDENT NEUTRON MEAN-LIFE AND PULSED EXPERIMENTS IN CRYSTALLINE MODERATORS. Ardente, V.; Rossi, G. (CCR-Euratom, Ispra, Italy). J. Nucl. Energy, 21: 559-63 (July 1967).

The decay of a thermalized neutron pulse in a small beryllium assembly is analyzed in terms of energy-dependent neutron mean lifetimes. It is shown that the time evolution of the total neutron density is correctly predicted by this approach once the moderator dynamics are described in suitable detail. The correct way of interpreting die-away time measurements is discussed. (auth) (UK)

42541 THE 'HEATING UP' OF NEUTRONS IN CRYSTALLINE MODERATORS. Grover, P. S.; Kothari, L. S. (Univ. of Delhi). J. Nucl. Energy, 21: 477-86 (June 1967).

When a pulse of low-energy neutrons is introduced inside a moderating assembly, the average energy of the neutron distribution increases with time. A study of this "heating up" process is described. The transient neutron spectra, the decay constant of the pulse, and the "heating up" relaxation time in beryllium assemblies of different size are calculated. It is found that for smaller assemblies, equilibrium of neutron distribution is reached faster than in bigger assemblies. For $B^2 = 0$, equilibrium is not reached even up to t = 700 μsec, the time up to which studies were made. For $B^2 = 0.01$ cm^{-2} "heating up" relaxation time is nearly 185 μsec. These results are in direct contrast with the slowing-down case, where equilibrium is reached faster in larger assemblies. The possible reasons for this behavior are discussed. (auth) (UK)

42542 CALCULATION OF MONOENERGIC NEUTRON LEAKAGE FROM TWO-DIMENSIONAL XY SMALL SYSTEM BY COLLISION PROBABILITY METHOD. Fukai, Y. (Nippon Atomic Industry Group Co., Ltd., Kanagawa, Japan). J. Nucl. Energy, 21: 447-68 (June 1967).

New collision probabilities developed for a two-dimensional XY system are used in the calculation of monoenergic neutron leakage from the small systems consisting of black absorbers and a homogeneous medium with an infinite height and isotropic scattering for neutrons. The derivation of the two-dimensional collision probabilities is presented; and, using the probabilities, neutron fluxes at each mesh point in a square homogeneous medium or systems with cruciform or box-type control rods are accurately calculated. Exact flow-out neutron currents from these systems are obtained from the resultant neutron fluxes and the escape probabilities from each mesh point. An equivalent radius for the square homogeneous medium is obtained by comparing the leakage rates from it with those from the infinite cylindrical medium which have been already calculated. Comparisons of the exact neutron leakage with that calculated by the diffusion theory for each system are discussed, and it is elucidated that calculation for such a small system shows a significant error. (auth) (UK)

42543 TEMPERATURE TRANSFORMATIONS AND THEIR APPLICATIONS TO THE REPRESENTATION AND ESTIMATION OF NEUTRON SPECTRA. Wexler, G. (Nuclear Power Group Ltd., Knutsford, Eng.). J. Nucl. Energy, 21: 469-76 (June 1967).

It is assumed that the result of a neutron spectrum problem has been given in the form of an expansion in the eigenfunctions of the heavy gas scattering operator at the local temperature T_s of the solid. It is shown that this information is sufficient to determine a similar expansion at an arbitrary neutron temperature. The problem of choosing an optimum temperature is discussed, and a formula is shown to accelerate the convergence of the neutron spectrum obtained by Kottwitz (1960) for a plane temperature discontinuity. It is suggested that a quadratic in the neutron energy multiplied by a Maxwellian function with a spatially varying temperature may be sufficient to describe many neutron spectra. (auth) (UK)

42544 CONSTRUCTION OF A NEW NEUTRON GENERATOR AT THE INSTITUT FUR RADIUMFORSCHUNG UND KERNPHYSIK. Munzer, H. Oesterr. Akad. Wiss. Math.-Naturwiss. Kl., Sitzungsber., 174: 567-74 (1965). (In German).

The construction of a neutron generator and the first operational experiments are described. The efficiency data correspond to that of the efficiency of commercially available neutron generators. (tr-auth)

42545 RADIONUCLIDE NEUTRON SOURCES IN TEACHING NUCLEAR CHEMISTRY. Tel'deshi, Yu.; Varga, Sh.; Dillinger, P. (Bratislav Polytechnic Inst.). Jad. Energ., 13: 253-64(July 1967). (In Czech).

Descriptions are given of neutron radiation installations available on the market and designed at the university. Data are presented on the radiation parameters of the devices and reactions of the neutron radiation with the substances and neutron detectors. The use of radioisotopic sources of neutron radiation in nuclear chemistry studies is discussed. (tr-auth)

42546 THE FOUNDATIONS OF NEUTRON TRANSPORT THEORY. An AEC Monograph. Osborn, Richard K.; Yip, Sidney. Monograph Series on Metallurgy in Nuclear Technology. New York, Gordon and Breach, Science Publishers Inc., 1966. 126p. $5.50.

An attempt is made to provide a more logical foundation of neutron transport theory in its present state of development. The justification of the transport equation within the framework of current analytical methods is stressed. A transport equation is derived in coarse-grained phase space; and binary neutron-nucleus interactions are discussed, beginning with a brief development of damping theory. The influence of the macroscopic medium on the reactions is studied, considering only radiative capture and elastic scattering by nuclei in gases and crystals. The velocity distribution of thermal neutrons is also discussed as are higher-order densities. (D.C.W.)

42547 THE DISCRETE SPECTRUM OF THE PLANE-SYMMETRY BOLTZMANN EQUATION. Congdon, Steven Paul. University Park, Pa., Pennsylvania State Univ., 1966. 114p.

Thesis.

The solution of the one-speed, plane-symmetry, stationary-state transport equation is considered. Since the one-speed, stationary-state solution can be applied to the resolution of less restricted transport problems, a more general problem is considered, viz., one in which c, the mean number of secondary neutrons per collision, is allowed to take on arbitrary complex values. The major attention is focused on the implicit variation with c of the discrete spectrum of the plane-symmetry Boltzmann operator. A new method is presented for analyzing the discrete spectrum. It yields the analytic behavior in the c-plane of the members of the discrete spectrum. The analysis of such behavior plays an important role in the resolution of the one-speed, time-dependent problem. For one-speed, stationary-state problems, this method describes both the number of members of the discrete spectrum and their respective arguments (in the sense of a complex number) as a function of the mean number of secondaries per collision and the angular distribution of the scattered neutrons. Application of this method to several representative scattering distributions reveals that for practically all scattering distributions used to describe neutron transport, and also for highly forward scattering distributions, the discrete spectrum consists of one real symmetric pair of members. It is also demonstrated that the singular eigenfunction expansion method is useful for the resolution of boundary-value problems in media with highly forward scattering. (Disser. Abstr.)

42548 NEUTRON SLOWING DOWN IN FINITE MODERATOR MEDIA FROM A FAST NEUTRON BURST. Leonard, Bobby Eugene. Raleigh, N. C., North Carolina State Univ., 1966. 124p.

Thesis.

The slowing-down of neutrons from a fast neutron "delta function" burst was examined. Constant and (1/v) variation of neutron absorption and scattering was considered as well as the diffusion approximation for neutron leakage from the systems. For these models, exact solutions are provided for constant and (1/v) absorption with constant scattering in finite hydrogen systems. A solution referred to as the "Energy Interval Method" was developed for nonhydrogenous moderators. The effect of a pulse of finite duration is also demonstrated. It was shown that the same information may be obtained by a source of long duration as with a "delta" function source. The important question as to whether slowing-down measurements appear feasible at very short times after the burst is explored. Criteria based on the P_1 approximation are established for the size of the system and minimum times for initiation of data collection in slowing-down measurements in order that these diffusion approximations may be applied. The existence of an accurate means of predicting the energy and time distributions of neutrons in the slowing-down regions will make possible the application of this information in new areas. The measurement of fast neutron parameters as proposed at the Symposium on Neutron Dynamics and Control (Leonard, 1965) appears to be possible. This can be seen from the fact that the slowing-down time and also the most probable time required for a neutron to slow to a given energy (obtained by equating the derivative of Φ to zero) are both functions of the absorption and scattering cross section. Thus, in principle, these quantities may be measured at any energy above thermal. Even in the cases where the minimum time for measurements due to finite time for establishment of harmonics is on the order of the slowing-down time the asymptotic part of the curve will provide a measure of these quantities. In heavy moderator assemblies such as lead assemblies, the neutrons remain "bunched" in the slowing-down process. An accurate knowledge of the energy of the "bunch" as may be obtained from this work renews the possibility of the use of lead assemblies pulsed by neutrons as neutron spectrometers. By observing the time-dependent variation of capture gammas from small samples located in an assembly, the total capture gamma cross sections may be measured as a function of time and thus energy. If a single-channel analyzer is used to discriminate the signals from a gamma scintillation crystal, individual capture gamma cross sections may be determined as a function of neutron energy. Thus information, important to nuclear physicists, on the excited states of the resulting nucleus formed in the radiative capture may be obtained. Finally, the results provide a mathematical form for the "slowing-down" region source as the neutrons slow into the "thermalization" region. (Disser. Abstr.)

42549 RELAXATION OF THE NUMERICAL STABILITY CRITERION IN FINITE-DIFFERENCE SOLUTIONS OF THE TIME-DEPENDENT NEUTRON-DIFFUSION EQUATIONS. Smiley, James William. University Park, Pa., Pennsylvania State Univ., 1966. 89p.

Thesis.

A new method of solving the space-time, nonlinear, neutron diffusion equations is presented. A direct numerical integration procedure is employed which has the generality and accuracy of a standard finite-difference solution, but does not require the usual time-step stability restriction, $\Delta t \leq (\Delta x)^2/2Dv$, frequently encountered in direct integration finite-difference solutions. In this study the time variation of the neutron flux is given by a time varying exponential period and is not approximated by the usual linear differencing scheme. This method of integration not only reduces the truncation error associated with the linear differencing scheme, but also provides a means for controlling the growth of errors in the solution. As a result, average time-step sizes several times larger than those normally required for stability in a finite-difference solution are possible. The STREAK computer program was written for the IBM 7074 computer to handle the numerics of the method. Some typical space-time problems are analyzed using the STREAK program and are compared to several other analytical methods currently employed in reactor analysis. Both the time and space agreement of the neutron distribution with these standard solutions is excellent. Moreover, the average integration time-step size is 3 to 4 times larger than the stability requirements normally allow in a finite-difference solution. The thesis also contains the results of some typical transient studies and some recommendations for other problem types which can be analyzed using the STREAK program. The version of STREAK as presented here is limited to one spatial dimension and two energy groups, however, extension to 2 or 3 dimensions or to more energy groups is easily accomplished. Up to six groups of delayed neutrons are allowed and almost any type of nonlinear feedback can be incorporated. STREAK can be employed to solve the space-independent kinetic equations, as well as to obtain space-dependent steady-state solutions. (Disser. Abstr.)

Nuclear Properties and Reactions, A≤ 5

Refer also to abstracts 41629 and 42702.

42550 (INFN/BE-67/1) ON THE SCATTERING OF NEUTRONS BY H_1^3 AND He_2^3 NUCLEI. Drigo, L.; Moschini, G.; Villi, C. (Istituto Nazionale di Fisica Nucleare, Padua (Italy)). Feb. 16, 1967. 9p. Dep.

Cross sections for neutron scattering by helium-3 and tritons and for the reaction $^3He(n,p)T$ are examined theoretically, with emphasis on conflicting experimental results in the published literature. Some of the critical aspects involved in present methods of analysis of unpolarized neutron data are discussed. (S.F.L.)

42551 (ITEF-501) NEUPRUGOE RASSEYANIE PROTONA NA DEITRONE. (Inelastic Scattering of a Proton on a Deuteron). Dubovoi, E. I. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1967. 16p. (In Russian). Dep.

A theoretical interpretation of some previously unreported experimental results for the reaction D(p,n)2p at 9 MeV is given; and, on the basis of qualitative properties of the differential

cross section as a function of kinematical variables, the reaction mechanism is identified. (auth)

42552 (UCRL-17605) π^--^{4}He INELASTIC AND CAPTURE REACTIONS LEADING TO EXCITED AND MULTI-NEUTRON FINAL STATES. Kaufman, Leon (California Univ., Berkeley. Lawrence Radiation Lab.). Aug. 1, 1967. Contract W-7405-eng-48. 85p. Dep. CFSTI.

Thesis.

A beam of 140 ± 0.5-MeV π^- was produced at the Berkeley 184-inch cyclotron and was used to study the final-state interactions of three and four neutrons, and to look for excited levels of the α particle through the reactions $\pi^- + {}^4He \rightarrow \pi^- + {}^4He^*$, $\pi^- + {}^4He \rightarrow p + 3n$, $\pi^- + {}^4He \rightarrow d + 2n$, and $\pi^- + {}^4He \rightarrow \pi^+ + 4n$. Only one such level is found, with an excitation energy of 32 MeV and an intrinsic width smaller than the 1-MeV resolution used. It was found that the data on the four-neutron final state are best fit by considering two neutrons interacting through a $^1S_0$ potential, and the two other neutrons as spectators. It was also found that deuteron production is down by a factor of ~10^3 from proton production and that the proton spectrum shows a stronger than expected interaction between the three neutrons in the final state. Lower limits for the production of a tri-or tetraneutron are set. (auth)

42553 PHASE SHIFTS FOR NEUTRON-ALPHA SCATTERING AT 25 AND 28 MeV. Hoop, B. Jr.; Huber, P. (Univ., Basel). Helv. Phys. Acta, 40: 710-12(Oct. 1, 1967).

A phase-shift analysis of some n-α scattering data at 25 and 28 MeV was made using a computer program that systematically varied an initial set of phase shifts until the square of the overall error of fit was minimized. The phase shifts that resulted in the best fit are given, and polarizations and differential cross sections that were calculated from these phase shifts are compared with the experimental data. (D.C.W.)

42554 HIGH-ENERGY PROTONS AS A NUCLEAR PROBE. Feshbach, H.; Kerman, A. K. (Massachusetts Inst. of Tech., Cambridge). Comments Nucl. Particle Phys., 1: 108-11(May 1967).

Experiments with the Brookhaven cosmotron are briefly reported in which advances in experimental technique have made it possible to investigate nuclei with high-energy proton probes. The 1-GeV protons used have a wavelength of 0.1 fermi. Energy resolution of the order of 2 MeV was obtained so that it was possible to clearly separate the elastic from the inelastic scattering for a variety of target nuclei. The differential cross section for proton elastic scattering by He is given between 0 and 60°. (S.F.L.)

42555 HALF-LIFE OF TRITIUM. Jordan, K. C.; Blanke, B. C.; Dudley, W. A. (Monsanto Research Corp., Miamisburg, Ohio). J. Inorg. Nucl. Chem., 29: 2129-31(Sept. 1967).

The half-life of tritium was determined by calorimetry to be 12.346 ± 0.002 yr (probable error by external consistency) by following the decay energy of two samples over a 6-yr period. (auth) (UK)

42556 CABIBBO-RADICATI SUM RULE AND PHOTODISINTEGRATION OF THREE-NUCLEON NUCLEI. Gerasimov, S. B. (Joint Inst. for Nuclear Research, Dubna, USSR). JETP Lett. (USSR) (Engl. Transl.), 5: 337-40(June 1, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 5: 412-14(June 1, 1967).

The application of the Cabibbo-Radicati sum rule, which relates the isovector radius of the charge distribution with the cross sections of the transitions that are brought about by the isovector part of the electromagnetic-current operator, to the nuclei ^{3}He and ^{3}H is considered. It is shown that for the sum rule to be valid, the reaction $\gamma + {}^3He \rightarrow n + 2p$ must go essentially through a state with $I = 3/2$. (D.C.W.)

42557 FORM FACTORS OF THE THREE-BODY NUCLEI; COULOMB SCATTERING AND THE FORM FACTOR OF THE PION. West, Geoffrey Brian. Stanford, Calif., Stanford Univ., 1966. 115p.

Thesis.

The dissertation is divided into two parts, each of which is concerned with electromagnetic scattering from "light" particles. In Part I relativistic corrections to Schiff's non-relativistic analysis of the three body nuclei form factors are estimated. High-energy electron scattering from these nuclei is re-examined using an impulse approximation in which the intermediate nucleon states are taken to propagate and interact as free particles. It is concluded that the corrections to the form factors are small (≲ 5%) for $-q^2 \leq 8f^{-2}$. However, it is shown that they assume great importance if the experiments are used to investigate the neutron charge form factor. Various effects arising from the use of the impulse approximation are discussed. These include considerations of current conservation, of the static limit ($q^2 \rightarrow 0$), and of the extraction of nuclear form factors from the impulse approximation nuclear current. A brief description of other classes of contributing intermediate states is given but no quantitative calculation of their effect is attempted. Part II is devoted to a discussion of the feasibility of a method suggested by Hofstadter for extracting the pion form factor from elastic $\pi^+ - \alpha$ scattering. Schiff has developed a perturbation formalism which permits the calculation of Coulomb effects without the use of Coulomb wave functions. Unfortunately, his expressions involve characteristic logarithmic divergences and a physical cut-off was proposed. Yennie, Gross and Bell have indicated a way by which the divergence can be removed in first order. Their result differs significantly from that of Schiff. The problem of scattering from Coulomb potentials (of infinite extent) was carefully examined, and it was shown that the standard inhomogeneous Lippmann-Schwinger equation no longer applies and that it must be replaced by its homogeneous counterpart. A technique is developed whereby integral equations, useful for obtaining non-divergent perturbative series for scattering from singular potentials, can be derived. This is applied to the case of Coulomb-like potentials and from the resulting inhomogeneous equation a divergenceless, cut-off-free, first-order perturbative result is obtained. The result is used in an analysis of some recent 24-MeV data obtained by Nordberg and Kinsey. Using a velocity-dependent optical model for the purely nuclear contribution and assuming reasonable forms for the π and α form factors, it is found that the experiments are not yet sufficiently accurate for a definitive value of the pion radius to be found. It is concluded that the root mean square radius of the pion, $r_\pi \lesssim 1.5f$, the experimental accuracy must be improved by an order of magnitude, and the best regions in which to take data (as far as a model independent result is concerned) are the regions of backward scattering. (Disser. Abstr.)

Nuclear Properties and Reactions, $6 \leq A \leq 19$

Refer also to abstracts 42417, 42580, 42614, 42696, 42701, 42717, 42721, and 42722.

42558 (ORNL-TM-1891) NEUTRONS FROM ^{9}Be(α,n) REACTION FOR E_α BETWEEN 6 AND 10 MeV. Verbinski, V. V.; Perey, F. G.; Dickens, J. K.; Burrus, W. R. (Oak Ridge National Lab., Tenn.). Aug. 24, 1967. Contract W-7405-eng-26. 25p. Dep. CFSTI.

Absolute differential cross sections were measured for the reaction ^{9}Be(α,n)^{12}C leaving ^{12}C in its ground, first-excited, and second-excited states as a function of angle and alpha bombarding energy. The angular distribution for the ground-state (0^+ state) transition changed from a fore-aft peaking at E_α = 6.8 MeV to a three-peaked angular distribution at E_α = 9.9 MeV. Similar behavior was observed for the second-excited-state transition (0^+). The angular distribution for the first-excited-state transition (2^+) displayed fore-aft peaking and was not sensitive to bombarding energy. A strong, low-energy neutron component, present at forward angles at all bombarding energies, can be accounted for by three- and four-body breakup reactions. It was determined that neutrons with energy ≤0.5 MeV account for ~30% of the total neutron production cross section from this reaction. (auth)

42559 (ORNL-TM-1926) LEVEL STRUCTURE IN ^{15}O FROM THE PROTON BOMBARDMENT OF ^{14}N. West II, Martin Luther (Oak Ridge National Lab., Tenn.). Sept. 1967. Contract W-7405-eng-26. 101p. Dep. CFSTI.

Thesis. Submitted to Univ. of Texas, Austin.

The elastic and inelastic scattering of protons from ^{14}N was investigated to obtain information on the excited states formed in the compound nucleus ^{15}O, as well as to study the nature of the "off-resonance" scattering. Angular distributions and excitation functions were measured in the range of incident proton energy from 3.7 to 5.7 MeV. Angular distributions for the reaction ^{14}N(p,α)^{11}C at 4.98 to 5.50 MeV were also obtained. Values for J^π, l, and Γ were determined. (D.C.W.)

42560 STUDY OF GIANT RESONANCES THROUGH RADIATIVE PION CAPTURE WITH APPLICATION TO ^{16}O. Murphy, J. D. (Catholic Univ. of America, Washington, D. C.); Raphael, R.; Ueberall, H.; Wagner, R. F.; Anderson, D. K.; Werntz, C. Phys. Rev. Lett., 19: 714-17(Sept. 18, 1967).

Using a generalized Goldharber-Teller model of the giant multipole resonance in ^{16}O, radiative pion-capture rates from 1s and 2p orbits, leading to various multipole isospin states in ^{16}N, were evaluated, and the corresponding γ spectra were obtained. The subsequent neutron emission was considered on the basis of Wigner's R-matrix theory. Whereas in 1s capture, the spectra are dominated by the dipole resonances, in the 2p capture there

is an even stronger contribution from the 2^+ and 3^+ quadrupole states. The total radiative capture rate compares favorably with experiment. (auth)

42561 SCATTERING OF 14-MeV NEUTRONS BY ^{12}C. Joseph, C.; Grin, G.-A.; Alder, J.-C.; Vaucher, B. (Univ., Lausanne, Switzerland). Helv. Phys. Acta, 40: 693-709(Oct. 1, 1967). (In French).

The angular distributions of the differential cross sections for scattering of 14.1-MeV neutrons from ^{12}C, Q = $0^{(0+)}$; $-4.43^{(2+)}$; $-7.65^{(0+)}$, and $-9.63^{(3-)}$ MeV, were measured using a time-of-flight spectrometer. An indication can be found of the excitation of a wide level at about 10 MeV. A Monte-Carlo program was developed and was used to correct the results for multiple scattering; it calculates time-of-flight spectra which can be compared with the measured spectra in order to deduce the best values of the cross sections. The results are finally confronted with other experimental determinations and existing theoretical predictions. (auth)

42562 ANGULAR DISTRIBUTIONS OF THE RECOIL NUCLEI FROM THE REACTIONS $^{12}(^3He,\alpha)^{11}C$ AND $^{12}C(^3He,d)^{13}N$. Hahn, Richard L. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Nucl. Phys., A101: 545-56(1967). (ORNL-P-3141).

Angular distributions of the ^{11}C and ^{13}N recoil nuclei from the reactions of 24.8-MeV ^3He particles with ^{12}C were determined by assay of the radioactive nuclides after their collection in catcher foils. Data for laboratory angles from 7 to 170° are presented. Structure in the ^{11}C angular distribution is readily apparent. A calculated ^{11}C angular distribution, based upon the distorted-wave theory of direct reactions, can reproduce essentially all of the details of the experimental data. It is concluded from these data that the $^{12}C(^3He,\alpha)^{11}C$ reaction proceeds predominantly by direct pick-up. Contrastingly, the ^{13}N recoil data, when compared with the data of Wegner and Hall for the $^{12}C(^3He,d_0)^{13}N$ reaction which can be fitted with the results of a direct stripping calculation, indicate that the (^3He,pn) reaction is a significant contributor (>60%) to the $^{12}C \rightarrow {}^{13}N$ cross section. Neither the shape nor the magnitude of the ^{13}N angular distribution can be explained on the basis of (^3He,d) stripping alone. (auth)

42563 ELASTIC ELECTRON SCATTERING EXPERIMENTS ON Be AND C AT 53 MeV AND THEIR ANALYSIS USING AN IMPROVED PHASE-SHIFT METHOD. Bentz, Hans Alfred (Technische Hochschule, Darmstadt); Engfer, Roland; Buehring, Wolfgang. Nucl. Phys., A101: 527-44(1967).

Cross sections for elastic electron scattering from beryllium were measured relative to carbon at the Darmstadt electron linear accelerator. The experimental data were analyzed with an improved phase-shift method which is described in detail. Using a recently obtained rms radius $R_m(C) = 2.42 \pm 0.04$ fm for carbon (natural isotopic mixture), the beryllium rms radius is $R_m(Be) = 2.46 \pm 0.09$ fm, and $R_m(Be)/R_m(C) = 1.015 \pm 0.024$. Using these results, a new analysis of a recent experiment yields $R_m(Ti) = 3.56 \pm 0.04$ fm for titanium (natural isotopic mixture). This radius is compared to that deduced from the muonic 2p-1s energy. (auth)

42564 THE ELECTRIC CHARGE FORM FACTOR OF ^6Li. Wong, S. S. M. (Univ. of Rochester, N. Y.); Lin, D. L. Nucl. Phys., A101: 663-72(1967).

The charge form factor of ^6Li is calculated in the intermediate coupling shell model using ground-state wave functions which give correctly many other nuclear properties of the state including the quadrupole moment. It is found that the effect of short-range correlation is important in explaining the large observed values of the charge form factor at high momentum transfers. (auth)

42565 INELASTIC SCATTERING OF 46 MeV PROTONS FROM ^{12}C. Petersen, E. L.; Slaus, I.; Verba, J. W.; Carlson, R. F.; Richardson, J. Reginald (Univ. of California, Los Angeles). Nucl. Phys., A102: 145-60(1967).

The differential cross sections for the excitation of nine levels of ^{12}C were measured each at 35 angles from 15° to 150°. The cross sections for the 4.4 and 9.6 MeV levels have a typical relative accuracy of 3%, while the measurements for the 7.7, 10.8, 11.8, 12.7, 14.1, 15.1 and 16.1 MeV levels have a typical accuracy of 10%. The cross sections decrease by from one to three orders of magnitude through the measured angular range. Levels at 13.3 and 16.6 MeV were not observed. The angular distributions were compared with distorted wave calculations using both macroscopic and microscopic approaches. (auth)

42566 THE EXCITED 4^+ STATES OF ^8Be. Kermode, M. W. (University of Liverpool, Eng.). Phys. Lett., 25B: 183-6(Aug. 21, 1967).

The experimental G wave phase shift for $\alpha-\alpha$ scattering is re-examined. Excited 4^+ states of ^8Be are found at 11.4, 19.4, and 26.7 MeV. The widths of these levels are 4.3, 0.36, and 25 MeV respectively. (auth)

42567 OBSERVATION OF T equals 2 LEVEL IN ^{20}Ne AS A COMPOUND NUCLEUS RESONANCE. Kuan, H. M.; Heikkinen, D. W.; Snover, K. A.; Riess, F.; Hanna, S. S. (Stanford Univ., Calif.). Phys. Lett., 25B: 217-19(Aug. 21, 1967).

The lowest T = 2 level in the self conjugate nucleus ^{20}Ne was observed as a sharp resonance in the once T-forbidden capture reaction $^{19}F(p,\gamma)^{20}Ne^{\ddagger}_{T=1}(\gamma)^{20}Ne$ and in the twice T-forbidden elastic scattering $^{19}F(p,p_0)^{19}F$. Resonance parameters are derived. (auth)

42568 ISOBARIC SPIN IMPURITY OF THE LOWEST T = 2 STATE IN ^{20}Ne. Bloch, R.; Pixley, R. E.; Truol, P. (Univ., Zurich). Phys. Lett., 25B: 215-17(Aug. 21, 1967).

A narrow s-wave resonance in $^{19}F(p,p)^{19}F$ was found at E_p = 4096 ± 3 keV which is attributed to the predominantly T = 2 states in ^{20}Ne expected at this bombarding energy. Least-squares analyses of the scattering data indicate that Γ is 2.1 ± 0.5 keV and Γ_p/Γ is 0.062 ± 0.004. (auth)

42569 STUDY OF THE $^7Li(p,\alpha)^4He$ REACTION. Lee, Chul-chu; Ko, Youn-kyu; Kim, Do-kyong (Yonsei Univ., Seoul). New Phys. (Korea), 6: 43-6(Dec. 1966).

The 8.7-MeV alpha particles produced from the $^7Li(p,\alpha)^4He$ reaction were measured by an Au–Si semiconductor detector and a G–M counter using the 300-kV Cockcroft–Walton accelerator which was recently constructed at the Physics Department. It was found that the 17.4-MeV Q_m value obtained in this reaction is close to the theoretical value. The yield ratio vs energy of the proton beam ranging from 80 to 210 keV was obtained. These results and an interpretation are presented. (auth)

42570 GAMMA RAYS RESULTING FROM INTERACTIONS OF 14.7-MeV NEUTRONS WITH VARIOUS ELEMENTS. Engesser, F. C.; Thompson, W. E. (Naval Radiological Defense Lab., San Francisco). J. Nucl. Energy, 21: 487-507(June 1967).

The prompt γ-rays resulting from the interaction of 14.7 MeV neutrons with the nuclei of natural C, N, O, Na, Mg, Al, Si, S, Cl, K, Ca, Ti, Fe, and Pb were investigated. Cross sections for the production of many of these γ-rays were measured by observing them with a carefully shielded detector during neutron bombardment of a given sample. It is found that in a given element the (n, n'γ) process usually predominates, but that in a few elements the (n, n'pγ) or (n, dγ) process predominates. Gamma rays resulting from the de-excitation of the lowest energy levels in the resulting product nuclei are generally most prominent. Gamma rays attributable to (n, pγ), (n, $\alpha\gamma$), and (n, n'$\alpha\gamma$) processes are also observed. Differential production cross sections for many γ-rays from these elements are tabulated in units of mb/sterad. at 90° per atom of naturally occurring element. Corrections to these values to account for γ-rays from radioactivity induced via the (n, p) production mode are included where applicable in the table of results. (auth) (UK)

42571 ENERGY AND ANGULAR CORRELATIONS FOR THE $^9Be(^3He,3\alpha)$ REACTION. Moazed, Cyrus George. College Park, Md., Univ. of Maryland, 1966. 108p.

Thesis.

The correlations in energy and angle of alpha particles produced in the reaction $^9Be(^3He,3\alpha)$ with 3-MeV incident ^3He were obtained by measuring the energies of two α particles in coincidence. The data indicate that the reaction proceeds dominantly through the intermediate states of ^8Be. Angular correlations for the reaction proceeding via the 16.92 MeV state of $^8Be(^9Be + {}^3He \rightarrow \alpha + {}^8Be(16.92) \rightarrow 2\alpha)$ were measured by varying the angle of observation of one of the break-up α particles of $^8Be(16.92)$ with the initial α particle emitted at fixed laboratory directions of 0, 20, 40, 60, 90, and 140°. These measurements were carried out in the initial reaction plane and in the plane perpendicular to it. The observed angular correlations involving the formation of the $^8Be(16.92)$ exclude the possibility of $J^\pi = 0^+$ for this state and established the assignment of $J^\pi = 2^+$. The distorted-wave stripping formalism was used in the analysis of the angular correlations from the ^9Be $(^3He,\alpha)^8Be(16.92) \rightarrow 2\alpha$ reaction, where the reaction was assumed to be a two-step process in which the first-step is a direct pickup. (Disser. Abstr.)

42572 DIFFERENTIAL AND TOTAL CROSS SECTIONS OF REACTION PRODUCTS FROM THE $^6Li + {}^6Li$ REACTION BETWEEN 2.4 AND 9.0 MeV. Kibler, Kenneth G. Iowa City, Iowa, Univ. of Iowa, 1966. 191p.

Thesis.

The $^6Li + {}^6Li$ reaction was studied at 13 incident energies between 2.4 and 9.0 MeV, using a dE/dx-E particle identification system and an on-line computer. Total cross sections and angular distributions were obtained for protons corresponding to the first

12 levels of ^{11}B, for deuterons from the first 5 T = 0 levels in ^{10}B, and for the triton from the ^{9}B ground state. Differential cross sections at 10° lab were obtained for the 16.62- and 16.92-MeV levels in ^{8}Be from the $^{6}Li(^{6}Li,\alpha)^{8}Be$ reaction. Noticeable variations of the proton angular distributions as a function of incident energy and indications of a 2J + 1 dependence of the proton cross sections as the bombarding energy was increased are indicative of compound nucleus effects. The proton cross sections are, however, smoothly varying within experimental statistics, which may indicate direct reaction effects. In particular, the large yields to the 7.30 and 7.99 MeV states in ^{11}B are suggestive of a direct 5-nucleon transfer to the ^{6}Li core, but the relative contributions of these competing reaction mechanisms are uncertain. In the $(^{6}Li,d)$ results, the dominant mechanism of interaction is via the transfer of an alpha particle, and this process is favored for the residual states which can be formed by an $l_\alpha = 0$ transfer. Simple considerations of the transfer as a tunneling process possibly modified by the presence of a long-range effective interaction adequately describes the deuteron cross sections. The differential cross section ratio of the 16.62- and 16.92-MeV levels in ^{8}Be was found to be 1.20 ± 0.05 and constant as a function of energy. This is consistent with a strong isospin admixture for these states. (Disser. Abstr.)

42573 AN INVESTIGATION OF THE COMPOUND NUCLEI ^{7}Li AND ^{7}Be. Spiger, Robert John. Pasadena, Calif., California Inst. of Tech., 1967. 329p.

Thesis.

The differential elastic scattering cross section was measured for the scattering of ^{3}He from ^{4}He and the scattering of ^{4}He from tritium. Incident particle energies of 5 to 18 MeV and 4 to 18 MeV, respectively, were used. Gas targets were used and solid-state silicon detectors were employed to detect the scattered particles. Data were also obtained for the reactions $^{4}He(^{3}He,p)^{6}Li$, $^{4}He(^{3}He,p^{1})^{6}Li^{*}$, $^{3}H(\alpha,n)^{6}Li$ and $^{3}H(\alpha,^{1}n)^{6}Li^{*}$. Levels are seen at 4.65, 6.64, 7.47 and 9.7 MeV in ^{7}Li and at 4.57, 6.73, 7.21 and 9.3 MeV in ^{7}Be. A phase-shift analysis suggests assignments of $\frac{7}{2}^-$ and $\frac{5}{2}^-$ for the two lower levels in ^{7}Li, confirms the $\frac{3}{2}^-$ assignment of the 7.47 level and suggests a $\frac{1}{2}^-$ assignment for the new level at 9.7 MeV. Similarly in ^{7}Be, the assignment of $\frac{7}{2}^-$ and $\frac{5}{2}^-$ for the lower two levels is reconfirmed and an assignment of $\frac{1}{2}^-$ is suggested for the new level at 9.3 MeV. The reduced widths for α and nucleon emission were determined by fitting the phase shifts near each level with a single and/or double level formula from the R-matrix formalism of Lane and Thomas (1958). The results of the analysis are discussed and compared with predictions of some recent nuclear model calculations. (Disser. Abstr.)

Nuclear Properties and Reactions, 20 ≤ A ≤ 89

Refer also to abstracts 42567, 42568, 42570, 42613–42615, 42634, 42638, 42648, 42680, 42687, 42701, 42717, and 42721.

42574 (AD-645244) NON-EXISTENCE OF A LEVEL AT 1.35 MeV IN ^{33}S. Moss, C. E. (California Inst. of Tech., Pasadena). Dec. 1966. Contract Nonr-220(47). 8p. CFSTI.

A natural sulfur target was bombarded with 2.541-MeV deuterons, and the emitted protons were observed with a magnetic spectrometer. The peak tentatively attributed earlier to a level at an excitation energy of 1.35 in sulfur-33 is shown to be due to levels in sulfur-34 at excitation energies of 4.08 and 4.12 MeV. (auth) (TAB)

42575 (BMwF-FBK-67-63) ^{77}Se–^{73}As: EIN BEITRAG ZUR MESSUNG UND DEUTUNG MAGNETISCHER MOMENTE ANGEREGTER EINTEILCHENNIVEAUS MITTELSCHWERER KERNE. (^{77}Se–^{73}As: A Report on the Measurement and Interpretation of Magnetic Moments of Excited Single Levels of Medium-Weight Nuclei). Engels, W. (Bonn Univ. (West Germany). Institut fuer Strahlen- und Kernphysik). July 1967. 85p. (In German). Dep.

The magnetic moments of the 248-keV state of ^{77}Se and the 66-keV state of ^{73}As were measured by the method of perturbed $\gamma\gamma$ angular correlations. The moments are $\mu = 1.05 \pm 0.10$ nm and $\mu = 1.62 \pm 0.11$ nm. The lifetimes of the states are 9.32 ± 0.18 ns and 5.0 ± 0.a ns respectively. The moments are discussed using the shell model and its various improvements. A rather consistent description of the behavior of ^{77}Se is obtained with the the Nilsson model. The moment of ^{73}As on the other hand is well explained in the framework of a seniority one and seniority three mixture as proposed by Freed and Kisslinger. (auth)

42576 (ITEF-478) SECHENIYA VZAIMODEISTVIYA DEITRONOV ENERGII 710 MeV S YADRAMI ^{27}Al. (Cross Section of Interaction of 710-MeV Deuterons with ^{27}Al Nuclei). Borisov, V. S.; Bysheva, G. K.; Gol'din, L. L.; Kondrat'ev, L. N.; Sidorenko, Z. S.; Sukhorukov, S. T.; Tumanov, G. K. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1966. 8p. (In Russian). Dep.

The cross sections of the interactions of deuterons with aluminium at 710 MeV are presented. The data are discussed in terms of the optical model for a complex particle, assuming the nucleus to be absolutely black. (auth)

42577 (LYCEN-6732) ETUDE D'UNE REACTION NUCLEAIRE A BASSE ENERGIE: LA REACTION $^{51}V(p,n)^{51}Cr$. (Study of the Reaction $^{51}V(p,n)^{51}Cr$ at Low Energy). Espi, Gisele (Lyon Univ. (France). Institut de Physique Nucleaire). May 1967. 99p. (In French). Dep.

Thesis.

The experimental curves of the excitation function of the neutrons emitted and the curve of their angular distribution as a function of the emission angle were studied in the reaction $^{51}V(p,n)^{51}Cr$ for incident protons of 2 MeV maximum. At this energy it was predicted that the reaction would occur with formation of an intermediate compound necleus of ^{51}Cr. Experiment verified this prediction. The neutron detection was made by time of flight by means of a plastic simulator associated with a time-amplitude analogue converter permitting discrimination of the neutrons from γ parasites by time of flight. ^{51}V targets of three different thicknesses were used. For each target the excitation curve for the neutrons emitted in the reactions and their angular distribution were determined. The excitation curve of slowing variable form obtained with a total resolution of 60 keV could be used as a function of the statistical model. The form of the excitation function is simular to that calculated by assuming the case where the statistical model is applied to the reaction. The excitation function obtained with a resolution of 14 keV shows large fluctuations which were explained by application of the Lane and Lynn fluctuation theory. It was deduced that there exists in the intermediate nucleus of ^{52}Cr for an excitation energy of the order of 12.2 MeV a course level structure. Data showed that this course structure is not covered over and that it is subdivided into a more finely constituted level structure which is covered over. The study of angular distribution curves confirmed these results. (J.S.R.)

42578 ELECTROMAGNETIC PROPERTIES OF LOW-LYING STATES OF ^{42}Ca. Gruenbaum, L. (Univ. of Surrey, London); Ganguly, N. K. Z. Phys., 205: 387-91 (1967).

The longitudinal form factors for the low-lying collective levels of ^{42}Ca were calculated using the wave functions of the nucleus as a linear combination of deformed and spherical states. A large discrepancy was found between the theoretical and experimental transition probabilities. (auth)

42579 ANGULAR CORRELATION MEASUREMENTS IN THE ^{52}Cr (p,nγ) ^{53}Mn REACTION. Saad, H. R.; El-Zaiki, M. I.; Mansour, N. A.; Abuzeid, M. A.; Popov, A. I.; Storizhko, V. E. (Atomic Energy Establishment, Cairo). Z. Phys., 205: 342-50 (1967).

The n-γ angular correlation measurements for the $^{52}Cr(p,n\gamma)$ ^{53}Mn reaction were performed at E_p = 2.3, 2.4, and 2.5 MeV. The neutron detector was located in the reaction plane at Θ_n = 45°, 90°, and 120° and perpendicularly to this plane at $\Theta_n = \Phi = 90°$. The experimental results obtained are in good agreement with predictions of the statistical compound-nucleus theory. (auth)

42580 THE (e,e'p) REACTION AND THE SEPARATION ENERGIES OF PROTONS IN NUCLEI. Campos Venuti, Gloria; Salvadori, Paolo (Istituto Superiore di Sanita, Rome). Ann. Ist. Super. Sanita, 2: 764-98(1966). (In Italian).

A review is given of the use of the (e, e'p) reaction for the study of separation energies of protons in nuclei. Results obtained from measurements on ^{9}Be, ^{12}C, ^{27}Al, ^{32}S, and ^{40}Ca nuclei and calculations on proton separation energies are reported. (S.F.L.)

42581 EXCITED STATES OF ^{23}Ne. Dumazet, Gerard; Beaumevieille, Henri; Lambert, Michel; Meynadier, Christian; Nguyen Van Sen (Institut d'Etudes Nucleaires, Alger, Algerie). Compt. Rend., Ser. A and B, 264: 1514-7(May 29, 1967). (In French).

A study was made of the absolute differential cross sections for nine transitions corresponding to the proton groups p_{0-4}, p_{6-9} of the $^{22}Ne(d,p)^{23}Ne$ reaction at E_d = 3 MeV were studied. Calculations of the form waves in the Born approximation (DWBA) were made in order to determine the angular orbital transfer moment l_n and the spectroscopic factors. (tr-auth)

42582 THE ISOMERIC EFFECT IN SZILARD–CHALMERS RECOIL OF ^{60m}Co AND ^{60g}Co IN Co (III) COMPLEXES IN RELA-

TION TO NEUTRON ENERGIES. Lazzarini, E.; Fantola Lazzarini, A. L. (Centro Studi Nucleari Enrico Fermi, Milan). J. Inorg. Nucl. Chem., 29: 2161-6(Sept. 1967).

The isomeric effect was measured in five Co(III) complexes irradiated with pile neutrons as well as with epicadmium neutrons. It was found that the value of the isomeric effect is lower in the case of the irradiations with epicadmium neutrons and that this lowering of the isomeric effect is parallel to the reduction in the amount of ^{60m}Co formed in comparison with the ^{60g}Co. This behavior agrees with the hypothesis, already discussed in previous papers, that the isomeric effect is due to formation of interstitial atoms of ^{60g}Co by decay, with internal conversion, of the ^{60m}Co, during the neutron irradiation. (auth) (UK)

42583 EXCITED LEVELS OF ^{28}Si INVESTIGATED BY INELASTIC SCATTERING OF 185-MeV PROTONS. Sundberg, O.; Johansson, A.; Tibell, G.; Dahlgren, S.; Hasselgren, D.; Hoeistad, B.; Ingemarsson, A.; Renberg, P.-U. (Univ. of Uppsala). Nucl. Phys., A101: 481-94(1967).

Energy spectra of protons scattered from a silicon target of natural isotopic composition were recorded in the angular range of 4° to 40° (lab system). The incident energy was 185 MeV, and the energy range of scattered protons corresponded to a region of excitation energies for ^{28}Si from 0 to 25 MeV. The full width at half maximum of resolved peaks in the spectra was 380 keV. The differential cross sections measured are presented in graphs giving the angular distributions for the resolved peaks. A qualitative discussion of the excited states which correspond to the observed peaks is presented and is based mainly on the shapes of the angular distributions. Comparisons are made with relevant results from similar experiments. (auth)

42584 CONTINUUM STRUCTURE OF ^{40}Ca. Delsanto, P. P.; Wahsweiler, H. G.; Greiner, W. (Univ., Frankfurt am Main). Phys. Rev. Lett., 19: 706-9(Sept. 18, 1967).

The total S^{1-} matrix of ^{40}Ca was calculated for excitation energies between 11 and 28 MeV. As typical results, the (γ,p_0) and the total absorption cross sections are shown and are compared with experiments. It is shown that the proper treatment of the one-particle, one-hole shell-model continuum accounts for most of the observed structures. (auth)

42585 SCATTERING OF HIGH-ENERGY ELECTRONS ON ^{27}Al, ^{31}P, AND ^{32}S AND THE CORE-EXCITATION MODEL. Lombard, R. M.; Bishop, G. R. (Ecole Normale Superieure, Orsay, France). Nucl. Phys., A101: 625-40(1967).

The nuclear properties of low-lying levels observed by high-energy electron scattering on ^{27}Al, ^{31}P, and ^{32}S are discussed in terms of a core-excitation model. The interaction is taken of the form $H_{int} = \Sigma_k T_c^k T_p^k$, where T_c and T_p are angular momentum operators for the core and the particle, respectively. The calculated E2 transition probabilities are in good agreement with experimental values, but the agreement is less satisfactory for M1 transition probabilities. (auth)

42586 THE SCATTERING OF HIGH-ENERGY ELECTRONS BY ^{27}Al. Lombard, R. M.; Bishop, G. R. (Ecole Normale Superieure, Orsay, France). Nucl. Phys., A101: 601-24(1967).

Measurements are reported of the cross section for elastic and inelastic scattering of high-energy electrons by the nucleus ^{27}Al. The elastic scattering is fitted well by a phase-shift calculation for a static charge density with parameters c = 3.07 fm and t = 2.28 fm. The contribution to the cross section arising from the nonspherical character of this nucleus was examined, and the quadrupole moment obtained is in good agreement with the spectroscopic value Q = 0.15 b. The inelastic cross sections are analyzed by expressions derived in first Born approximation, and the analysis leads to measurements on a number of levels of ^{27}Al. (auth)

42587 POLARIZATION AND ASYMMETRY IN THE ELASTIC AND INELASTIC SCATTERING OF 50-MeV PROTONS BY ^{24}Mg, ^{64}Zn, AND ^{68}Zn. Lewis, V. E. (King's Coll., London); Burge, E. J.; Rush, A. A.; Smith, D. A.; Ganguly, N. K. Nucl. Phys., A101: 589-600(1967).

Measurements are reported of the polarization and asymmetry produced in the elastic and inelastic scattering of 50-Mev protons by ^{24}Mg, ^{64}Zn, and ^{68}Zn. The results cover the angular range 10 to 145° (lab). The inelastic scattering is to the first excited state. The results for ^{24}Mg and ^{64}Zn together with differential cross-section data were analyzed using the simple optical model. The best fits were obtained for a spin-orbit potential of smaller radius than the real central potential. (auth)

42588 COULOMB EXCITATION OF ^{45}Sc, ^{75}As, ^{127}I, AND ^{133}Cs. Imanishi, N. (Kyoto Univ.); Fukuzawa, F.; Sakisaka, M.; Uemura, Y. Nucl. Phys., A101: 654-62(1967).

The Coulomb excitation of ^{45}Sc, ^{75}As, ^{127}I, and ^{133}Cs was studied using 11.5-MeV nitrogen ions as bombarding particles. From the thick target yields of de-excitation gamma rays, the B(E2) ↑ values are obtained as ^{45}Sc: 378 keV, 0.0086 ± 0.0017; ^{75}As: 280 and 199 keV, 0.051 ± 0.012 and 0.015 ± 0.003; ^{127}I: 203 and 59 keV, 0.072 ± 0.014 and 0.054 ± 0.011; ^{133}Cs: 160 and 81 keV, 0.13 ± 0.03 and 0.022 ± 0.004, respectively, in units of e^2b^2. The results for ^{127}I and ^{133}Cs are compared with theoretical predictions. (auth)

42589 DECAY OF ^{47}Ca. Hsue, S. T.; Kim, M. U.; Langer, L. M.; Spejewski, E. H.; Willett, J. B. (Indiana Univ., Bloomington). Contract Nonr-1705(2). Nucl. Phys., A101: 688-97(1967).

A detailed investigation of the decay of ^{47}Ca was made by means of a Ge(Li) detector and a shaped magnetic field spectrometer. The ^{47}Ca half-life was determined to be 4.623 ± 0.032 day. The gamma-ray measurements yield the following transition energies: 489.2 ± 0.7, 529.6 ± 1.3, 766 ± 1.8, 807.9 ± 0.7, and 1296.6 ± 0.7 keV. These are combined with previous results fitted into a level scheme for ^{47}Sc resulting in excited states at 766.83 ± 0.30, 807.91 ± 0.20, and 1296.85 ± 0.18 keV. The beta spectrum measurements indicate a nearly statistical shape for the highly retarded (log ft = 8.5), allowed ground-state-to-ground-state transition. The possibility that this beta spectrum has a non-statistical shape, however, can not be completely excluded. The endpoint energies, intensities, and log ft values for the beta groups are: 1980.6 ± 2.6 keV, ≥15.1%, 8.5; 1213.8 keV, <0.1%, >9.8; 1172.7 keV, <1.0%, >8.8; and 683.7 keV, 83.9%, 6.0. (auth)

42590 THE NUCLEAR LEVEL STRUCTURE OF ^{76}As FROM A STUDY OF THE ^{75}As(n,γ)^{76}As REACTION. Siddiqi, T. A.; Fiebiger, N.; Stelzer, K. (Univ., Frankfurt am Main). Nucl. Phys., A101: 673-87(1967).

The neutron capture γ radiation from the reaction ^{75}As(n,γ)^{76}As was studied using a Li-drifted germanium detector. The energies of low-lying excited levels are deduced from the high-energy γ transitions. The level density is compared with a theoretical formula of Gilbert and Cameron. Coincidence spectra were measured with NaI(Tl) crystals, a five-crystal pair spectrometer being used for the measurement of high-energy γ rays. A decay scheme was proposed for the 302- and 515-keV levels, to which strong transitions are observed from the capturing state. The possible shell-model configurations of these levels, of the ground state of ^{76}As and of the ground state of ^{75}As are discussed. It is shown that the strong high-energy transitions to the 302- and 515-keV excited levels may be due to a direct capture of thermal neutrons into shell-model p-states. The spins of the latter levels are predicted to be 1^+ and 2^+. (auth)

42591 THERMAL-NEUTRON CAPTURE GAMMA RAYS FROM NATURAL MAGNESIUM AND ENRICHED ^{25}Mg. Spilling, P.; Gruppelaar, H.; Op Den Kamp, A. M. F. (Rijksuniversiteit, Utrecht). Nucl. Phys., A102: 209-25(1967).

Gamma rays from neutron capture in natural magnesium and in enriched ^{25}Mg were studied with Ge(Li) detectors. Altogether 101 γ-rays were observed. Most of these γ-rays could be fitted into the level schemes of ^{25}Mg, ^{26}Mg, and ^{27}Mg. The Q-values for the following reactions were determined: ^{24}Mg(n,γ)^{25}Mg, Q = 7332.8 ± 0.4 keV; ^{25}Mg(n,γ)^{26}Mg, Q = 11096.0 ± 0.5 keV; ^{26}Mg(n,γ)^{27}Mg, Q = 6446.3 ± 0.9 keV; ^{56}Fe(n,γ)^{57}Fe, Q = 7643.9 ± 1.5 keV; ^{63}Cu(n,γ)^{64}Cu, Q = 7916.5 ± 1.5 keV; ^{207}Pb(n,γ)^{208}Pb, Q = 7371.0 ± 2.5 keV. If it is assumed that the capture cross section for natural magnesium amounts to 64 ± 3 mb, the capture cross sections for ^{24}Mg, ^{25}Mg, and ^{26}Mg were determined as 52 ± 13 mb, 182 ± 50 mb and 34 ± 10 mb, respectively. (auth)

42592 THERMAL-NEUTRON CAPTURE GAMMA RAYS FROM NATURAL CALCIUM. Gruppelaar, H.; Spilling, P. (Rijksuniversiteit, Utrecht). Nucl. Phys., A102: 226-36(1967).

Gamma rays from thermal-neutron capture in natural Ca and enriched ^{40}Ca were investigated with a 5 cm^3 Ge(Li) detector. Many low-energy γ-lines were found. More than 90% of the γ-rays result from capture in ^{40}Ca and about 5% from capture in ^{44}Ca. From the data a decay scheme of ^{41}Ca and a partial decay scheme of ^{45}Ca were constructed. The Q-values for the reactions ^{40}Ca(n,γ)^{41}Ca and ^{44}Ca(n,γ)^{45}Ca were determined as Q = 8363.4 ± 1.0 and 7418.1 ± 3.0 keV, respectively. In ^{41}Ca, it is found that hole states preferentially decay to hole states, and single-particle states to single-particle states. (auth)

42593 EXCITED STATES OF ^{81}Br. Evans, K. R.; Ajzenberg-Selove, F. (Haverford Coll., Pa.). Nucl. Phys., A102: 237-40 (1967).

A total of 33 previously unreported states of ^{81}Br in the region $1 < E_x < 6$ MeV was observed in the reaction ^{80}Se(^{3}He,d)^{81}Br using a broad-range spectrograph and a 15 MeV ^{3}He beam from the University of Pennsylvania tandem accelerator. (auth)

42594 THE REACTION ^{39}K(d,n)^{40}Ca. Bass, R.; Lehmann, C.; Quast, U. (Johann-Wolfgang-Goethe-Univ., Frankfurt am Main). Nucl. Phys., A102: 190-202(1967).

The reaction $^{39}K(d,n)^{40}Ca$ leading to the ground state of the final nucleus was investigated with a stilbene neutron spectrometer, using metallic targets of natural K and pulse shape discrimination against γ-rays. Excitation functions of the absolute differential cross section at $\theta_{lab} = 0°$ and 30° were measured over the energy region $E_d = 2.9$ to 6.2 MeV with an energy resolution of the order of 100 keV. In addition angular distributions were obtained at $E_d = 4.0$, 5.0, 5.5, and 6.0 MeV. The excitation functions show broad, but pronounced structure, apparently indicating the presence of a compound nucleus or intermediate contribution to the reaction mechanism. On the other hand the angular distributions exhibit a stripping pattern and are rather insensitive to energy changes. The results are compared with DWBA calculations, and their possible implications with respect to spectroscopic parameters and the reaction mechanism are discussed. (auth)

42595 ISOBARIC ANALOGUE STATES OF ^{47}Ca. Gaarde, C.; Kemp, K.; Wilhjelm, P. (Univ. of Copenhagen). Nucl. Phys., A102: 1-10(1967).

The analog states of the low-lying levels in ^{47}Ca were studied via the (p,p) and (p,p') reactions on ^{46}Ca. Resonances seen at bombarding energies of 1.863, 2.768, and 3.95 MeV were identified as analog states to the 2.013, 2.878, and 4.049 MeV excited states in ^{47}Ca. For analog resonances below the neutron threshold the compound elastic scattering was taken into account. It is shown that by including the compound elastic contribution the shape of the resonance determines not only the l-value but also the spin. Partial and total widths are given and spectroscopic factors are calculated. The elastic proton widths Γ_p correspond well with the results obtained from the $^{46}Ca(d,p)$ reaction. From the inelastic widths new information about the structure of the states in ^{47}Ca is obtained. (auth)

42596 SEARCH FOR AN INTERMEDIATE STRUCTURE IN NEUTRON TOTAL CROSS SECTIONS. Cabe, J.; Laurat, M.; Yvon, P.; Bardolle, G. Nucl. Phys., A102: 92-104(1967). (In French).

The study of the neutron total cross section between 0.5 and 1.2 MeV for the nuclei ^{51}V, ^{52}Cr, ^{55}Mn, ^{56}Fe and ^{59}Co in which the neutron number is close to 28, shows the presence of gross structure in the excitation function underlying the compound nucleus resonances for vanadium and iron. The structure in ^{56}Fe has been studied in a more detailed way by measuring the angular distributions at several energies in the above range and the elastic scattering excitation curves at angles where the first six Legendre polynomials have zeros. (auth)

42597 ALLOWED K-CAPTURE TO POSITRON EMISSION RATIOS IN THE DECAYS OF ^{48}V AND ^{52}Mn. Konijn, J.; Lewin, W. H. G.; Van Nooijen, B.; Van Beek, H. F.; De Wit, S. A.; Lingeman, E. W. A. (Instituut voor Kernphysisch Onderzoek, Amsterdam Laboratorium voor Technische Fysica, Delft, Netherlands). Nucl. Phys., A102: 129-44(1967).

Branching ratios of K-capture to positron emission probabilities were measured for the allowed beta transitions in ^{48}V and ^{52}Mn by triple-gamma coincidence experiments with NaI(Tl) counters and also by beta gamma coincidence measurements with a proportional counter-NaI(Tl) crystal arrangement. The results $K/\beta^+ = 0.69 \pm 0.03$ for ^{48}V and $K/\beta^+ = 1.72 \pm 0.11$ for ^{52}Mn are in good agreement with theoretical predictions. (auth)

42598 EXCITATION FUNCTIONS FOR $(^3He,\gamma)$ AND $(^4He,\gamma)$ REACTIONS. Carlson, R. V.; Daly, P. J. (Purdue Univ., Lafayette, Ind.). Nucl. Phys., A102: 161-76(1967). (COO-1672-2).

In order to investigate the effect of particle composition on the probability of radiative capture, excitation functions were determined for radiative capture of 5 to 42 MeV ^4He ions by ^{115}In and ^{127}I and of 3 to 33 MeV ^3He ions by ^{41}K, ^{45}Sc and ^{71}Ga using radiochemical techniques. The (α,γ) excitation functions are closely similar, rising to maxima of 150 to 170 μb at about 17 MeV bombarding energy and falling to less than 10 μb above 30 MeV. At energies above the Coulomb barrier, the $(^3He,\gamma)$ cross sections are essentially constant at about 20 μb for $^{41}K(^3He,\gamma)$, 15 μb for $^{45}Sc(^3He,\gamma)$ and 25 μb for $^{71}Ga(^3He,\gamma)$. (auth)

42599 PARTICLE-HOLE CALCULATIONS FOR ^{40}Ca. Hill, L. L. (Naval Ordnance Lab., Silver Spring, Md.). Phys. Lett., 25B: 169-72(Aug. 21, 1967).

The particle-hole model was applied to obtain the 0^-, 1^-, and 2^- giant resonance states in ^{40}Ca. These eigenstates are then used to calculate the E1 and M2 form factors for inelastic electron scattering, the R-matrix theory nucleon decay widths, the excitation spectra for inelastic electron scattering at 180°, and the muon capture rate. (auth)

42600 SECOND O^+, T = 1 LEVEL IN ^{30}P. Harris, G. I.; Hyder, A. K. Jr. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). Phys. Lett., 25B: 210-12(Aug. 21, 1967).

Gamma-ray triple-correlation and polarization measurements at the $J^\pi = 1^-$ resonance at $E_p = 1375$ keV in $^{29}Si(p,\gamma)^{30}P$ yield the unique assignment $J^\pi = 0^+$ for the recently discovered 4.468 MeV state in ^{30}P. This state is identified as the T = 1 analog of the 3.786 MeV. $J^\pi = 0^+$ state in ^{30}Si. (auth)

42601 THE $^{48}Ca(alpha,p)^{51}Sc$ REACTION; EXPERIMENTAL RESULTS AND SHELL MODEL CALCULATIONS. Ginaviη, R. O. (Massachusetts Inst. of Tech., Cambridge); Bernstein, A. M.; Drisko, R. M.; McGrory, J. B. Contract W-7405-eng-26. Phys. Lett., 25B: 206-8(Aug. 21, 1967). (ORNL-P-3282).

The $^{48}Ca(\alpha,p)^{51}Sc$ reaction at 31 MeV was used to make spin and parity assignments to several levels in ^{51}Sc. A shell model calculation is in good agreement with the observed spectrum. (auth)

42602 NEW ENERGY LEVELS IN ^{64}Zn, ^{66}Zn, ^{68}Zn AND ^{70}Zn. Calderbank, M.; Burge, E. J.; Smith, D. A. (King's College, London). Phys. Lett., 25B: 201-3(Aug. 21, 1967).

New energy levels observed in the inelastic scattering of 49 MeV protons are reported. A magnetic spectrometer was used to separate the levels. (auth)

42603 THE SPIN CUT-OFF FACTOR FOR ^{60}Co. Paulsen, A. (EURATOM, Geel, Belg.). Z. Phys., 205: 226-34(1967).

Nine experimental isomeric cross-section ratios for the reactions $^{59}Co(n,\gamma)^{60}Co$, $^{60}Ni(n,p)^{60}Co$, and $^{63}Cu(n,\alpha)^{60}Co$ are analyzed in terms of statistical theory by means of the method of Huizenga and Vandenbosch. The γ cascades are treated by a model which was recently published. The results confirm the energy dependence of the spin cut-off factor for ^{60}Co $\sigma \sim U^{\frac{1}{2}}$, which should not be neglected. As a mean value, $\sigma = 4.3 \pm 0.3$ is obtained for $U = B_n = 7.5$ MeV, in good agreement with a nuclear moment of inertia for a rigid sphere. (auth)

42604 ON THE USE OF COINCIDENCE MEASUREMENTS WITH THE ANNIHILATION QUANTA FOR POSITRON DETECTOR EFFICIENCY DETERMINATIONS AND THE epsilon/beta$^+$ RATIO OF ^{22}Na. Vatai, Endre. ATOMKI (At. Kut. Intez.) Kozlem., 9: 91-4(June 1967). (In Russian).

Preliminary description for determining the ratio ϵ/β^+ is given making use of $(\beta^+\gamma^+)$ coincidence measurements for positron detector efficiency determination. A 4π scintillation counter was applied as positron detector and the nuclear (γ) and annihilation (γ^+) gamma rays was detected by two separate NaI(Tl) crystals. The alternations applied make easier the necessary corrections in comparison with the method of Williams. (auth)

42605 (d,γ) AND (d,2n) REACTIONS WITH 0- TO 15-MeV DEUTERONS. Pement, Fredric William. Pittsburgh, Univ. of Pittsburgh, 1965. 184p.

Thesis.

Excitation functions for the $^{30}Si(d,\gamma)^{32}P$ and $^{138}Ba(d,\gamma)^{140}La$ reactions and for nine (d,2n) reactions are measured radiochemically for bombarding energies up to 15 MeV. The $^{30}Si(d,\gamma)$ excitation function is fairly flat above 5 MeV at ≈110 to 160 μb. The $^{138}Ba(d,\gamma)$ excitation function peaks at ≈24 μb near 10 MeV. The (d,2n) cross sections all show sharp rises above threshold, leveling off near the (d,3n) thresholds at values near those for compound-nucleus formation. Statistical model calculations using Fermi gas level densities and continuum-theory cross sections reproduce the (d,γ) and (d,2n) excitation functions, both as to magnitude and energy dependence. Statistical model Monte Carlo approaches are modified for γ and 2-neutron emission, and the equations and parameters are discussed in detail. The (d,2n) reactions are also treated theoretically assuming an alternate mechanism: neutron evaporation from an excited nucleus formed by (d,n) stripping. This stripping-evaporation mechanism results in theoretical cross sections of up to 25% of the observed (d,2n) cross sections, but the degree of interference between it and the compound nucleus mechanism is not readily discernible. It is concluded that compound statistical features are of primary importance in these deuteron-induced reactions. (Disser. Abstr.)

42606 ^3He-INDUCEDD REACTIONS IN NICKEL AND ZIRCONIUM. Rundquist, David Edwin. Urbana, Ill., Univ. of Illinois, 1966. 174p.

Thesis.

The stable isotopes of nickel and zirconium, with the exception of ^{96}Zr, were bombarded with a 25-MeV ^3He beam. Elastic, inelastic, and $(^3He,\alpha)$ absolute cross sections were measured. The $(^3He,\alpha)$ angular distributions for l-transfers of one and three were found to contain J-dependent effects. Least-squares, optical-model fits were obtained to the observed elastic scattering data. Collective-model, distorted-wave Born approximation (DWBA) calculations were performed for the inelastic transitions. Deformation parameters were extracted from the data. Finite-range, nonlocal potential corrections were included in the DWBA $(^3He,\alpha)$ analysis

by the use of the local energy approximation. Spectroscopic factors were extracted. Some discussion on the merits of the (^{3}He,α) reaction as a general nuclear spectroscopic tool is presented. (Disser. Abstr.)

42607 SURVEY OF THE REACTION ^{35}Cl(d,2p)^{35}S g.s. Brown, Peter Frank. Pittsburgh, Univ. of Pittsburgh, 1966. 113p.
Thesis.

The ^{35}Cl(d,2p)^{35}S g.s. reaction was studied at a deuteron energy of 15 MeV. Solid-state detectors were used to detect the protons and the energy spectra of the coincident protons were determined by means of a 64 × 64-channel analyzer. Measurements were made at different angular combinations (θ_1,θ_2) such that the two detectors and the beam were always in the same plane. It is found that the angular distribution of the differential cross section for $\theta_1 = \theta_2$ is peaked in the forward direction. The ratios $d\sigma(40°,40°) : d\sigma(90°,90°) : d\sigma(130°,130°)$ are 4.0 : 0.90 : 1.0. When $\theta_1 \neq \theta_2$, it is found that the energy spectra of the protons in the forward detector are peaked towards the high-energy end. Both of these effects suggest that a large fraction of the reaction proceeds via a direct mechanism. A calculation was made in terms of a two-step model for the reaction process. First, the deuteron breaks up near the surface of the ^{35}Cl nucleus with the proton being scattered, while the neutron is captured. Second, a proton is evaporated from the excited ^{36}Cl nucleus to the ground state of ^{35}S. The calculation reproduces the behavior of the energy spectra of the unequal angle runs ($\theta_1 \neq \theta_2$) surprisingly well. (Disser. Abstr.)

42608 SU_3 PARTICLE–HOLE STATES IN ^{40}Ca. Larner, Donald. Ames, Iowa, Iowa State Univ. of Science and Tech., 1966. 100p.
Thesis.

The contributions of the one-particle one-hole excitations to the negative-parity levels of ^{40}Ca are calculated. The basis states are harmonic oscillator states symmetrized according to SU_3, and in the process of constructing these states, some Clebsch-Gordan coefficients for the (30) representation are computed. The residual interaction employed is the Kallio-Kolltveit potential, which uses the Moszkowski-Scott separation method. The energy matrix is computed directly from the SU_3 states, using the projection integral method of Elliott. Nine states are obtained, seven of which may be compared with experimental data on the low-lying states of ^{40}Ca. Five of these seven states show very good agreement with experiment. (Disser. Abstr.)

42609 A STUDY BY MEANS OF SECONDARY REACTIONS OF FRAGMENTS PRODUCED IN COPPER BY HIGH-ENERGY PROTONS AND ALPHA PARTICLES. Dierenfeldt, Karl Emil. Davis, Calif., Univ. of California, 1966. 127p.
Thesis.

Copper targets were bombarded with 270- to 730-MeV protons and 330- to 880-MeV alpha particles. Target thicknesses were varied for proton bombardments and 330-MeV alpha-particle bombardments. The secondary isotopes ^{69}Ge (produced by lithium fragments), ^{71}As, and ^{72}As (produced by beryllium fragments) were studied. For proton bombardments, the ^{69}Ge apparent cross sections rose rapidly with increasing proton energy. For alpha particles they were essentially constant for all bombarding energies. The ^{71}As and ^{72}As apparent cross sections were constant for all proton energies, while for alpha-particle bombardment they were constant up to 600 MeV and increased slowly above this. In all cases, the apparent cross sections from alpha particles were larger than those from proton bombardments. Calculations indicated that the ^{69}Ge data were best fit by a combination of an evaporation and a monoenergetic, forward-directed, lithium-fragment energy spectrum. Lithium fragments produced by alpha particles had higher mean energies than those produced by protons. The cross section for lithium fragments formed by 330-MeV alpha particles was two times the same cross section for 730-MeV protons, indicating that alpha particles produce lithium fragments much more efficiently. The ratios of the apparent cross sections for ^{71}As and ^{72}As were constant for both proton and alpha-particle bombardment, indicating that the shapes of the fragment spectra are constant. Beryllium fragments produced by alpha particles had much higher mean energies than those produced by protons, just as for lithium fragments. (Disser. Abstr.)

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Refer also to abstracts 40959, 42329, 42373, 42531, 42570, 42588, 42598, 42605, 42606, and 42717.

42610 (IN–1060) ETA RATIOS OF ^{239}Pu AND ^{241}Pu RELATIVE TO ^{235}U. Fast, E.; Aber, E. F. (Idaho Nuclear Corp., Idaho Falls). Aug. 1967. Contract AT(10-1)-1230. 42p. Dep. CFSTI.

The ratios of the neutron reproduction constants η(Pu-239)/η(U-235) and η(Pu-241)/η(U-235) were determined from reactivity measurements in ARMF-I and ARMF-II. Results for 2200 m/sec and Maxwellian average values are given. (auth)

42611 (NAA-SR-12501) HIGH TEMPERATURE MEASUREMENTS OF DOPPLER EFFECT IN UC AND UO_2 BY METHOD OF TEMPERATURE-CYCLED REACTIVITY OSCILLATION. Beller, L. S.; Heneveld, W. H. (Atomics International, Canoga Park, Calif.). Aug. 1, 1967. Contract AT(04-3)-701. 33p. Dep. CFSTI.

Interim measurements of the Doppler effect in nominally 0.5-cm-diameter samples of natural uranium carbide and uranium dioxide are reported for temperatures up to 1330°C. The measurements were made as part of the investigation of the method of making Doppler-effect measurements by oscillating the temperature to produce a direct measurement of dI/dT. The measured ratio of specific reactivity effects for UC/UO_2 between 1030 and 1330°C was 1.23 ± 0.15, in satisfactory agreement with calculation. The Doppler effects in UO_2 are in agreement with extrapolations from data of others obtained at lower temperatures. The methods and equipment for making Doppler-effect measurements by this method are described. It is concluded that the method is entirely practical, producing results of precision comparable to that obtained by standard methods. Certain advantages of this method were used to identify quantitatively sources of interference not accessible to other methods. (auth)

42612 (NP–16816) DISTRIBUTIONS DES ESPACEMENTS DES RESONANCES ET VALEURS DES COEFFICIENTS DE CORRELATION ENTRE LES DIFFERENTS PARAMETRES. (Distributions of Resonance Intervals and Values of Correlation Coefficients in Different Parameters). de Barros, S.; Chevion, P. L.; Julien, J.; Morgenstern, J.; Samour, C.; Jackson, H. (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro). 1966. 20p. (In French). Dep.

The distributions of neutron resonance spacings and the values of correlation coefficients between different parameters were calculated for Au, Tm, Pt, Ag, and ^{238}U either considered alone or in groups. (J.S.R.)

42613 (NP–16992) ANNUAL REPORT, APRIL 1966–MARCH 1967. (Tokyo Univ. (Japan). Inst. for Nuclear Study). 154p. Dep.

TIN-118—proton reactions (p,t) at 55 MeV, differential cross sections for
ZINC-68—proton reactions (p,t) at 55 MeV, differential cross sections for
ZINC-67—proton reactions (p,d) at 55 MeV, differential cross sections for
CADMIUM-110 and -114—proton differential inelastic scattering cross sections at 55 MeV
SAMARIUM-150, -152, and -154—proton reactions (p,t) at 55 MeV, triton energy spectrum and angular distributions for
ZIRCONIUM-90—proton reactions (p,d) at 55 MeV, zirconium-89 energy levels from
ZIRCONIUM-90—proton reactions (p,t) at 55 MeV, zirconium-88 energy levels from
ZIRCONIUM-91—proton reactions (p,d) at 55 MeV, zirconium-90 energy levels from
ZIRCONIUM-91—proton reactions (p,t) at 55 MeV, zirconium-89 energy levels from
PROTONS—reactions (p,t) with zirconium-91 at 55 MeV, zirconium-89 energy levels from
YTTRIUM-89—proton reactions (p,d) at 55 MeV, yttrium-88 energy levels from
NIOBIUM-93—proton reactions (p,d) at 55 MeV, niobium-92 energy levels from
ALUMINUM-27—energy levels from proton elastic and inelastic scattering at 55 MeV
BERYLLIUM-9 and CARBON-12—proton reactions (p,p′α) at 55.3 MeV, angular correlation distribution for
PROTONS—interactions with protons at 52.34 MeV, differential cross sections for; interactions with protons at 50 MeV, spin correlation parameters for
STRONTIUM-83—beta and electron-capture decay of, gamma spectrum from
RUBIDIUM-83—electron-capture decay of, gamma spectrum from
RHODIUM-100—beta and electron-capture decay of, ruthenium-100 energy levels from
CESIUM-136—beta decay of, beta–gamma delayed coincidence study of,

SYNCHROTRONS—design and operation at Tokyo University
PROTONS—interactions $\gamma + p \rightarrow p + \eta^0$ at 890 MeV, polarization recoil protons in
DEUTERONS—interactions $\gamma + d \rightarrow \pi^0 + d$ at 650 to 820 MeV, differential cross sections for
TIN-117, -118, -119, and LEAD-208—proton reactions (p,d) at 55 MeV, differential cross sections for (S.F.L.)

42614 (ORO-2791-26) ANNUAL PROGRESS REPORT [ON GAMMA-RAY PRODUCTION CROSS SECTIONS AND ANGULAR DISTRIBUTION MEASUREMENTS]. (Texas Nuclear Corp., Austin). Aug. 15, 1967. Contract AT(40-1)-2791. 152p. Dep. CFSTI.

A description of the gamma-ray production cross sections and angular distribution measurements made during the year is given, and a summary of the present status of the overall cross section program at Texas Nuclear Corporation is included. Those elements studied during this reporting period included Mn, V, Fe, Nb, W, Pb, Na, Ce, Y, Bi, Sb, B, In, Co, Ta, Ag, Sc, Tl, Au, Cu, Al, Si, and A. The addition of a large-volume, coaxially drifted Ge(Li) detector to the spectrometer system is described along with details of the cross calibration of the Texas Nuclear Corp. long counter. Plans for interfacing the newly acquired 1600 channel analyzer with the IBM 1130 computer system are also presented. Theoretical studies based on the theories of Hauser-Feshbach and Satchler, suitably modified by appropriate width-fluctuation corrections, were continued and led to the assignment of nuclear level spins and parities. A discussion of the theoretical work in progress is given. (auth)

42615 (RPI-328-97, pp 1-34) NEUTRON CROSS SECTIONS. (Rensselaer Polytechnic Inst., Troy, N. Y.).

Neutron resonance scattering by Rh at 125 to 450 eV was investigated experimentally. The analysis of neutron capture data up to 200 keV for Al, Fe, Ni, and Na neared completion; capture areas and resonance widths were obtained. An analysis of self-indication data for Fe gave a relation between Γ_n and Γ_γ for each resonance. The investigation of neutron capture by F, Pb, ^{206}Pb, ^{207}Pb, Mg, and S at 1 to 100 keV was extended to include ^{204}Pb; values of $g\Gamma_n\Gamma_\gamma/\Gamma$ were obtained from the data. (D.C.W.)

42616 (WAPD-TM-625) MEASUREMENT OF CHANGE IN α AND FISSION RATE WITH TEMPERATURE FOR ^{238}U (LWB-LSBR DEVELOPMENT PROGRAM). Green, L. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Aug. 1967. Contract AT(11-1)-Gen-14. 21p. Dep. CFSTI.

The Doppler effect of an enriched (93.2%) UO_2 target in a 1/E incident neutron spectrum was investigated in a beam geometry. The fission and capture rates of the target, enclosed in a quartz glass furnace, were followed by means of two scintillation counters operating a crossover-pickoff coincidence system. Analysis of the time data yields change in α, the capture to fission ratio, and in the fission integral, as a function of temperature. A single target 0.090-inch thick was studied in the range from room temperature to 800°C. Experimental conclusions obtained were the capture to fission ratio, α, increased with temperature, and within a 2% uncertainty no change was observed in the fission rate over the temperature interval studied. Monte Carlo calculations using recent resonance data were performed for the conditions of the experiment and agreement was obtained with these conclusions. (auth)

42617 LARGE CHANGE OF L_3 ELECTRON BINDING ENERGY IN ^{239}Pu INDUCED BY AN EXTERNAL ELECTROSTATIC FIELD. Novakov, T.; Janicijevic, P. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). Z. Phys., 205: 359-71(1967).

^{239}Np sources, prepared in different chemical states, were exposed to a high electrostatic field ($\approx 10^7$ V/cm). L-subshell conversion electrons of the 57.2-keV transition were studied in a high resolution double focussing spectrometer. It was found that large shifts (≈100 eV) of the L_3 binding energy can be induced by the action of the field, while the L_1 binding energy remains practically unchanged. The binding-energy shifts depend on the chemical state of the source. Shifts are observed when chloride and oxide sources are used. With hydroxide sources no shifts were observed. (auth)

42618 GAMMA TRANSITIONS IN THE DECAY OF ^{195m}Pt. Bashandy, E.; El-Sayad, G. M. (Atomic Energy Establishment, Cairo). Z. Phys., 205: 351-8(1967).

The gamma transitions in the decay of ^{195m}Pt were investigated by the use of a high-resolution double-focusing beta-ray spectrometer. Conversion electrons were observed for transition of energy 79.94 ± 0.32 keV and were ascribed for the first time to the decay of 4.2 d ^{195m}Pt. This confirmed that the 209-keV level decays either by the 208.81-keV transition (98%) or by a 79.94 keV–128.51 keV cascade (2%). The multipolarity assignment for each transition in ^{195}Pt was obtained by comparing the measured conversion line intensity ratios with the theoretical line intensity ratios of Sliv and Band. Two gamma transitions of nearly equal energy (129 and 130 keV) could be detected; the former was found to be pure E2 transition, while the latter has an M4 character. The mixing ratio of some gamma rays were determined, and some discrepancies were found. The data were discussed in the light of Coulomb excitation results. (auth)

42619 STUDIES OF ^{147}Gd AND ^{147}Eu DECAY. Avotina, M. P.; Grigor'ev, E. P.; Zolotavin, A. V.; Sergeev, V. O.; Ter-Nersesyants, V. E.; Vrzal, Ya.; Lebedev, N. A.; Liptak, Ya.; Urbanets, Ya. (Leningrad State Univ. Joint Inst. for Nuclear Research, Dubna, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1292-1303(Aug. 1966). (In Russian).

An attempt was made to interpret the properties of nuclear levels (A = 140 to 150) within the limits of generalized or single-particle models. Isotopic decay of ^{147}Gd and ^{147}Eu was analyzed at transition levels A = 145 to 153. Two β spectrometers with double focusing at an angle of $\pi\sqrt{2}$ were used for studying conversion electron spectra. The order of error for the measured energy of transitions was within 0.02 to 0.07%. A coaxial Ge(Li) detector with the sensitivity volume ~5cm^3 at the 6 mm drift depth, and 2048-channel amplitude analyzer with ~5.5 keV resolving power at the 1332 keV line of ^{60}Co were used for studying γ spectra. Semi-conductor detector calibrations were carried out using the energies obtained by measuring the spectra of conversion electrons of $^{146, 147, 148}$Gd and $^{145, 146, 147}$Eu. The efficiency of the γ spectrometer was determined using ^{226}Ra and ^{169}Yb. The isotopes of the Gd and Eu fractions were prepared by irradiation of the Ta and Er targets by 660 MeV protons followed by chemical purification. In the conversion electrons and γ ray spectra were observed the lines of ^{146}Gd (half life 46 days) ^{147}Gd(38.5 hr), ^{148}Gd(9.3 days), ^{151}Gd(120 days), ^{153}Gd(200 days) and their daughter isotopes ^{146}Eu (4.5 days), ^{147}Eu(24 days), and ^{149}Eu(100 days). (R.V.J.)

42620 MEASUREMENTS OF THE ^{233}Pa RESONANCE INTEGRAL. Connor, J. C.; Bayard, R. T.; Macdonald, D.; Gunst, S. B. (Westinghouse Electric Corp., West Mifflin, Pa.). Nucl. Sci. Eng., 29: 408-14(Sept. 1967).

The neutron-capture resonance integral of ^{233}Pa was measured by irradiating cadmium-covered thorium wires, and, after suitable chemical separations, determining the quantity of ^{234}U produced. Results are reported for two methods of measuring the irradiating flux. Monitor wires of cobalt in aluminum alloy give integrated fluxes based upon a value of 72.0 b for the resonance integral of ^{59}Co. Alternatively, measurements of the ^{233}U produced by the irradiations give integrated fluxes based upon an effective resonance integral of 36.5 b measured for the ^{232}Th wires. The experiments provide ^{233}Pa resonance integral results of 846 ± 43 b employing cobalt-monitored fluxes, and 837 ± 43 b employing thorium-monitored fluxes. These results, which have an average value of 842 ± 35 b, include the $1/\nu$ component of the cross section, and are appropriate for a 1/E spectrum and a perfect filter with a low energy cutoff of 0.50 eV. (auth)

42621 TOTAL NEUTRON CROSS SECTION OF ^{232}U. Simpson, O. D.; Moore, M. S.; Berreth, J. R. (Idaho Nuclear Corp., Idaho Falls). Nucl. Sci. Eng., 29: 415-22(Sept. 1967).

The neutron total cross section of ^{232}U was measured from 0.01 to 10,000 eV using the Materials Testing Reactor (MTR) fast chopper. A 2200 m/sec total neutron cross section of 163 ± 10 b was determined. Multilevel parameters are listed for resonances below 30 eV. Results of the analysis indicate that two fission channels are needed to describe the experimental data. (auth)

42622 TOTAL NEUTRON CROSS SECTION OF ^{228}Th FOR THE 1.9- AND 7.5-eV RESONANCES. Simpson, O. D.; Schuman, R. P.; Berreth, J. R. (Idaho Nuclear Corp., Idaho Falls). Nucl. Sci. Eng., 29: 423-4(Sept. 1967).

The total neutron cross section of ^{228}Th was measured in the regions of 1.9 and 7.5 eV, with the Materials Testing Reactor (MTR) fast chopper. The ^{228}Th occurred as a contaminant in several samples of the parent ^{232}U, on which cross-section measurements were being made at various decay times. For the two resonances which grew in with enough prominence to allow analysis, the resonance parameters are deduced. (auth)

42623 GAMMA-RAY SPECTRA OF THE PRODUCTS OF FAST-NEUTRON FISSION OF ^{235}U AND ^{238}U AT SELECTED TIMES AFTER FISSION. Bunney, L. R.; Sam, D. (Naval Radiological Defense Lab., San Francisco). Nucl. Sci. Eng., 29: 432-43(Sept. 1967).

Experimental measurements of the gamma-ray pulse-height distributions due to the products of fast-neutron-induced fission of ^{235}U and ^{238}U are presented. The measurements were made at nine selected times: 0.25, 0.5, 1, 2, 5, 10, 24, 48, and 72 h after

fission. Irradiation times and counting intervals were chosen to minimize saturation and decay effects. The experimental data were used to calculate 100 energy-bin distributions of the absolute number of photons/(fission sec) by means of absolute calibrations of the collimated NaI(Tl) detector. The number of fissions in each sample was determined radiochemically. Machine computation was used extensively. (auth)

42624 STRING EFFECT WITH 5 MeV PROTONS AND 20 MeV ALPHA PARTICLES ON BISMUTH. Ellegaard, Clive; Lassen, N. O. Kgl. Dan. Vidensk. Selsk., Mat.-Fys. Medd., 35: No. 16, 1-16(1967).

The yield of backward elastic scattering (150°) of 5-MeV protons and 20-MeV α particles from a single crystal of bismuth was found to depend on the orientation of the crystal with respect to the beam direction. When the latter coincides with the trigonal axis of the crystal the yield has a deep minimum, the angular width of which agrees with Lindhard's formula. Smaller and narrower minima in the yield are found when the beam is parallel to low index crystal planes. The effect is found to increase when the crystal is cooled to liquid nitrogen temperature. The string effect decreases with the depth below the surface, at low temperature, with a factor of two in about 10 μm. The variation is found to correspond to an almost linear increase in Ω^2, the mean square angular width of the beam, which may be understood as a result of the thermal vibrations of the atoms. (auth)

42625 INTERNAL CONVERSION COEFFICIENTS M OF THE TRANSITIONS $E_2(2^+ \rightarrow 0^+)$ OF ^{160}Dy AND ^{166}Er. Arnoux, Micheline; Gizon, Andree (Centre d'Etudes Nucleaires, Grenoble, France). Compt. Rend., Ser. A and B, 264: 1518-21(May 29, 1967). (In French).

The ratio $M_I/M_{II}/M_{III}/(M_{IV} + M_V)$ are respectively (142 ± 20)/(935 ± 30)/1000/(34 ± 5) for the 86.74-keV transition of ^{160}Dy and (82 ± 10)/(925 ± 30)/1000/(13 ± 2) for the 80.57 keV transition of ^{166}Er. (tr-auth)

42626 γ EMISSION FOLLOWING THE β DECAY OF ^{233}Pa. Briancon, Chantal; Leang, Chin Fan; Paris, Pierre (CNRS, Orsay, France). Compt. Rend., Ser. A and B, 264: 1522-5(May 29, 1967). (In French).

The γ spectrum emitted during the decay of ^{233}Pa was studied using Ge junctions. A comparison was established with previous results obtained by crystalline diffraction. (tr-auth)

42627 THE DECAY OF ^{132}I. Ardisson, Gerard (Faculte des Sciences, Nice). Compt. Rend., Ser. C, 264: 1999-2002 (June 19, 1967). (In French).

The decay scheme of ^{132}I should be modified by taking into consideration new data on its γ radiation. Several new excited states of ^{132}Xe were proposed. (tr-auth)

42628 EXPERIMENTAL STUDY OF THE (^{3}He,d$\bar{p}$) REACTION. Hoffswell, R. A.; Jamnik, D.; Noweir, T. M.; Yavin, A. I. (Univ. of Illinois, Urbana). Contract 00014-67-A-0305-0005. Phys. Rev. Lett., 19: 754-6(Sept. 25, 1967).

The reaction ^{90}Zr(He-3, d$\bar{p}$) ^{90}Zr, in which isobaric analog states are excited by the (He-3,d) reaction and decay by proton emission, was investigated at an ^{3}He energy of 18.7 MeV. Deuteron and proton spectra were measured including deuteron-proton coincidence spectra. (D.C.W.)

42629 PRECISION MEASUREMENTS OF SPECTRA OF CONVERSION ELECTRONS ON A NEW HEIDELBERG β SPECTROMETER WITH $\pi/2\sqrt{13}$ ANGLE FOCUSING. Daniel, Kh.; Yan, P.; Todt, V. (Inst. of Nuclear Physics, Heidelberg). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 2022-4(Dec. 1966). (In Russian).

Strong conversion lines from the decay of ^{192}Ir were measured on the iron-free spectrometer which due to its new principle of focusing had a relatively high solid angle of 0.01 with a high resolution of 4.8×10^{-4}. A thin layer of Ir was sputtered onto an Al backing 1.3 mg/cm^2 thick and irradiated in a reactor to give a source 1 cm high and 0.02 cm wide. The calculated and measured line widths for the 58, 218, and 390 keV conversion electrons were in excellent agreement, even at the low energy of 58 MeV, which showed that there was no line broadening due to source thickness. The measured width varied from 5.5 to 8.8×10^{-4}. The error in determining the momentum of K-electrons was 5×10^{-6}. Six L/K ratios were measured with an accuracy of 1×10^{-5}. Precise measurements of the ratios of conversion intensities at the L-subshells were carried out, and a comparison with theory indicated a pure E2 transition ($2^+ \rightarrow 0^+$). (TTT)

42630 LIFETIMES OF EXCITED NUCLEAR STATES IN ^{115}In. Hrynkiewicz, A. Z. (Inst. of Nuclear Physics, Krakow); Ogaza, S.; Rybicka, M.; Kulessa, R.; Walus, W. Acta Phys. Pol., 32: 77-84(July 1967).

The lifetimes of the 597-, 829-, and 864-keV excited states of ^{115}In were measured by means of beta-gamma and gamma-gamma delayed coincidence techniques. The corresponding results are: $T_{1/2}$(597 keV) < 200 psec, $T_{1/2}$(829 keV) = 6.00 ± 0.12 nsec, and $T_{1/2}$ (864 keV) = 1.13 ± 0.06 nsec. (auth)

42631 INFLUENCE OF CORIOLIS COUPLING, PAIRING, AND OCTUPOLE VIBRATION-PARTICLE COUPLING ON $\Delta K = -1$ E1 TRANSITIONS IN ^{177}Hf. Bernthal, F. M.; Rasmussen, J. O. (Univ. of California, Berkeley). Contract W-7405-eng-48. Nucl. Phys., A101: 513-26(1967). (UCRL-17504).

A fit of 14 $\Delta K = -1$ E1 transitions in ^{177}Hf to within 20% of experimentally derived absolute intensities was achieved by considering the principal and Coriolis-mixed E1 components as three adjustable parameters. Subsequent theoretical calculations using Nilsson wave functions and including the effects of pairing, Coriolis coupling, and octupole vibration-particle coupling yielded a fit to within a factor of two for the ^{177}Hf E1 intensities. Only one adjustable parameter, the octupole vibration-particle coupling strength, was used in the microscopic calculations. Three new transitions including two new E1 transitions were observed in the decay of ^{177m}Lu. Improved E1 relative intensity measurements are presented for comparison with theory. (auth)

42632 GAMMA-RAY TRANSITIONS IN ^{106}Pd FOLLOWING THE DECAY OF ^{106m}Ag. Temperley, J. K.; Temperley, A. A. (U. S. Army Nuclear Defense Lab., Edgewood Arsenal, Md.). Nucl. Phys., A101: 641-53(1967).

The gamma-ray spectrum following the decay of ^{106m}Ag to ^{106}Pd was investigated with a Ge(Li) detector. The energies and relative intensities of 35 gamma rays were determined. A level scheme for ^{106}Pd is proposed. Using the conversion-electron intensities measured by previous investigators, the internal conversion coefficients of the transitions were calculated and used to assign spin and parities to the levels. (auth)

42633 SINGLE-PROTON STATES IN ^{209}Bi CORRESPONDING TO THE SHELL 82 < Z < 126. Lilley, J. S.; Stein, Nelson (Univ. of Washington, Seattle). Phys. Rev. Lett., 19: 709-13(Sept. 18, 1967).

The reaction ^{208}Pb(α,t)^{209}Bi was studied to investigate the single-proton states following Z = 82. The excitation energies and shell-model assignments for the observed states in ^{209}Bi are as follows: ground state, $1h_{9/2}$; 0.90-MeV, $2f_{7/2}$; 1.61-MeV, $1i_{13/2}$; 2.84-MeV, $2f_{5/2}$; and 3.14-Mev, $3p_{3/2}$. (auth)

42634 NEUTRON ENERGY SPECTRA AND ANGULAR DISTRIBUTIONS FROM TARGETS BOMBARDED BY 45-MeV ELECTRONS. Gayther, D. B.; Boode, P. D. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Energy, 21: 733-47(Sept. 1967).

The time-of-flight method was used to measure the energy spectra of neutrons emitted by targets of natural uranium, lead, bismuth, and tungsten when bombarded by 45-MeV electrons from the Harwell linear accelerator. The spectra were measured at 90° to the electron beam and covered the energy range 40 keV to 6 MeV. For targets 3 cascade shower radiation lengths in thickness the mean energy of the neutrons was found to be 1.92 MeV for lead and 1.37 MeV for uranium, and the relative yield from lead to that for uranium was 0.47 ± 0.05. For targets of lead, bismuth, and tungsten, the observed spectra could be represented over a large energy range by Maxwellian distributions at temperatures of 0.98, 0.82, and 0.44 MeV, respectively. The angular distributions of the neutrons from lead and uranium targets were determined from foil activation measurements using the threshold reactions ^{31}P(n,p)^{31}Si, ^{27}Al(n,p)^{27}Mg, and ^{27}Al(n,α)^{24}Na. For a small uranium target forward peaking of the emitted neutrons relative to the electron beam direction was observed. The development of larger targets of uranium and lead which act as isotropic neutron sources for use in reactor physics measurements is described. (auth) (UK)

42635 A MEASUREMENT OF THE ^{235}U FISSION CROSS SECTION AT 30 AND 64 keV. Knoll, G. F.; Poenitz, W. P. (Kernforschungszentrum, Karlsruhe, Ger.). J. Nucl. Energy, 21: 643-52(Aug. 1967).

The fission cross section of ^{235}U was measured absolutely at 30-keV neutron energy using kinematically collimated neutrons at the threshold of the ^{7}Li(p,n)^{7}Be reaction. The number of fission events in a 1.2 mg/cm^2 U_3O_8 foil was determined by counting fission fragments in a gas scintillation detector. The neutron flux was measured both by counting of the induced ^{7}Be activity in the target and through a parallel measurement of the induced ^{198}Au activity in a gold foil. Another measurement was made at 64 keV using the ^{3}H(p,n)^{3}He reaction at threshold as the neutron source. The flux was normalized in this case by assuming a value for the ^{197}Au capture cross section ratio at the two energies. Values obtained for the fission cross section are 2.19 ± 0.06 barns at 30 keV and 1.78 ± 0.13 barns at 64 keV. (auth) (UK)

42636 THE FISSION CROSS SECTIONS OF ^{233}U, ^{234}U, ^{236}U, ^{238}U, ^{237}Np, ^{239}Pu, ^{240}Pu, AND ^{241}Pu RELATIVE TO THAT OF

^{235}U FOR NEUTRONS IN THE ENERGY RANGE 1 TO 14 MeV. White, P. H.; Warner, G. P. (Atomic Weapons Research Establishment, Aldermaston, Eng.). J. Nucl. Energy, 21: 671-9(Aug. 1967).

The fission cross sections were measured relative to the fission cross section of ^{235}U to an accuracy of approximately ±2% at neutron energies of 1.0, 2.25, 5.4, and 14.1 MeV. Combining these ratios with the known values of the fission cross section of ^{235}U leads to fission cross sections having an estimated uncertainty of ±3.5% and which are mostly in agreement with other recent measurements. (auth) (UK)

42637 MEASUREMENT OF THE NEUTRON CAPTURE CROSS SECTIONS OF ^{147}Pm, ^{148}Pm, ^{148m}Pm, AND ^{147}Sm. Fenner, N. C.; Large, R. S. (Atomic Weapons Research Establishment, Aldermaston, Eng.). J. Inorg. Nucl. Chem., 29: 2147-53(Sept. 1967).

The neutron capture cross sections of ^{147}Pm and the ^{148}Pm isomers were measured by reactor irradiation of ^{147}Pm and mass spectrometry. The samarium daughter product formed during and after irradiation was separated chemically from the promethium and the cross section derived from the relative abundance of the samarium isotopes. The values for the thermal cross sections obtained, assuming a ^{59}Co 2200 m/sec thermal cross section of 37.4 barns were: for ^{147}Pm(n,γ)^{148m}Pm (41.5 days), 72 ± 7 barns; for ^{147}Pm(n,γ)^{148}Pm (5.4 days), 82 ± 8 barns; for ^{148m}Pm (41.5 days) (n,γ)^{149}Pm, 22,000 ± 2500 barns. The corresponding resonance capture integrals for the first two reactions were: 700 ± 200 barns and 720 ± 230 barns. The cross section of the reaction ^{147}Sm(n,γ)^{148}Sm was obtained from direct spectrometric analysis following reactor irradiation of a sample separated from aged ^{147}Pm. The values found were: thermal, 51 ± 3 barns, and resonance integral, 640 ± 200 barns. (auth) (UK)

42638 A NOTE ON THE DOPPLER BROADENING OF RESONANCES. Beynon, T. (Univ. of Birmingham, Eng.). J. Nucl. Energy, 21: 681-5(Aug. 1967).

It is shown that the invariance of the integral $\int_0^\infty \sigma(E)\, f(E)dE$ with temperature is not a fundamental property of the neutron cross section. Assumptions made in the evaluation of the integral in the laboratory system are investigated and show that the area preservation property of the truly narrow resonance is sufficiently valid for all reactor calculations and that the following assumptions—the contribution to the integral from $-\infty$ to $-2E_0/\Gamma$ is negligible and Γ_γ and Γ have no energy dependence over the range of integration, and $\xi = \Gamma\sqrt{(M/4\ pk\ TE_0)}$—examined numerically for resonances of ^{238}U, ^{56}Fe, and ^{239}Pu, have an effect small enough to be considered negligible. It is concluded however, that the assumption of temperature invariance for trains of overlapping resonances may be a possible source of error where strong interference effects occur. (UK)

42639 THE (n,γ) ABSORPTION CROSS-SECTION OF ^{146}Pm FOR REACTOR NEUTRONS. Pinajian, J. J.; Allen, J. F. (Oak Ridge Natioal Lab., Tenn.). J. Inorg. Nucl. Chem., 29: 2117-19 (Aug. 1967).

The presence of even small amounts of ^{146}Pm in megacurie ^{147}Pm power sources may introduce severe shielding problems, and since ^{147}Pm in large quantities is available only from fission product recovery processes ^{146}Pm is inherently present. The long half-life of ^{146}Pm precludes allowing the ^{146}Pm to decay to negligible levels within a reasonable time. Neutron irradiation of the ^{146}Pm–^{147}Pm product affords a possible means of reducing the ^{146}Pm content by burnup if the (n,γ) absorption cross section of ^{146}Pm is sufficiently large. This communication describes measurements of this cross section. The amount of ^{147}Pm produced in the course of burnup of ^{146}Pm can not be accurately determined in the presence of ^{146}Pm since ^{147}Pm is a weak beta emitter with no associated gamma emission. The most convenient method is to determine the loss of ^{146}Pm. Experimental details are described, using cyclotron irradiation of $^{146}Nd_2O_3$ to produce the ^{146}Pm and ion exchange separation of Nd and Pm, followed by reactor irradiation of the ^{146}Pm. The ^{146}Pm loss amounted to 26.7%, from which the (n,γ) absorption cross section of ^{146}Pm was calculated to be 8400 ± 1680 barns. (UK)

42640 A NEW DETERMINATION OF WESTCOTT'S s_O FACTOR FOR THE REACTION ^{109}Ag(n,γ)^{110m}Ag. Bresesti, A. M.; Bresesti, M.; Neumann, H. (CCR-EURATOM, Ispra, Italy). J. Inorg. Nucl. Chem., 29: 2477-9(Sept. 1967).

Interest in this factor was mainly due to its utilization in the measurement of the epithermal index + $\sqrt{T/T_0}$ in long irradiations of materials. The $s_{O,Ag}$ value was determined by cadmium ratio measurements on silver and gold. In order to minimize self-shielding corrections, the silver and gold were irradiated as disks of dilute alloys with aluminum. The irradiations were performed with different core configurations in two positions of the graphite reflector of the Ispra I reactor, very close to the heavy water tank, the thermal neutral flux in these positions being ~2×10^{13} N/cm^2/sec. After a suitable cooling time to allow decay of short half-life impurities, the activities of ^{110m}Ag and ^{198}Au were measured by gamma spectrometry. The calculated average value for $s_{O,Ag}$ was 17.88 ± 0.09 (standard error) or 17.88 ± 0.50 (including the uncertainty in $S_{O,Au}$). The expression used for the calculation is given. The value obtained is discussed. (UK)

42641 THERMAL NEUTRON CAPTURE CROSS SECTION AND RESONANCE CAPTURE INTEGRAL OF THE LANTHANIDE NUCLEI ^{140}Ce, ^{142}Ce, ^{146}Nd, ^{148}Nd, ^{150}Nd, AND ^{159}Tb. Alstad, J.; Jahnsen, T.; Pappas, A. C. (Univ. of Oslo). J. Inorg. Nucl. Chem., 29: 2155-60(Sept. 1967).

The thermal neutron capture cross sections σ_{th} and the resonance capture integral I_0 for some lanthanide nuclei were measured by an activation method. Thin gold foils (σ_0 = 98.8 barns, I_0 = 1558 barns) were used as flux monitors. The resonance integrals for ^{142}Ce, ^{146}Nd, and ^{150}Nd have not been published previously. In addition, the effective neutron capture cross sections σ_{eff} in the JEEP reactor at JENER, Kjeller, are given. (auth) (UK)

42642 AUTOMATIC SYSTEM FOR RAPID MEASUREMENT OF THIN FOILS IRRADIATED IN REACTOR BEAM. Mavroyannakis, E. G.; Zikides, C. C.; Chrysochoides, N. G. (Democritus Nuclear Research Center, Athens). J. Sci. Instrum., 44: 766-8(Sept. 1967).

An experimental rig was built to enable the measurement of rapidly disintegrating excited nuclei emitted from thin foils irradiated in the reactor beam. A special collimator ensures short transfer time of the irradiated sample and quick cut-off of the neutron beam. An automatic system permits accurate repetition of the various movements and functions of the system. The rig is at present used for the measurement of the energy spectrum of delayed neutrons from uranium-235 by the time-of-flight technique. (auth) (UK)

42643 THERMAL NEUTRON CAPTURE CROSS SECTION OF ^{121}Sb AND ^{123}Sb. Orvini, E.; Maxia, V. (Univ. Pavia, Italy). Energ. Nucl. (Milan), 14: 541-3(Sept. 1967).

Power reactor safety in terms of containment for fission product release from the core under abnormal operation and safeguard systems is discussed. Loss-of-coolant accidents are analyzed from the points of: initiation of the accident; description of the accident; and countermeasures to mitigate its consequences. (D.C.C.)

42644 MEASUREMENT OF THE g-FACTORS OF TWO LEVELS OF ^{131}I. Tandon, P. N.; Devare, H. G. (Tata Inst. of Fundamental Research, Bombay). Nucl. Phys., A102: 203-8(1967).

The g-factors of the 150 keV first excited state and a state at 1797 keV of ^{131}I were measured from the rotation ωτ of the angular correlation pattern in an external magnetic field. The integral method was used and coincidence counting rates at 135° were recorded for two directions of the field. The gamma-ray cascades involved are 452–150 keV in the case of the 150 keV state and 102–200 keV for the 1797 keV state. The results are: ωτ = 0.097 ± 0.012 for a magnetic field of 13.2 kG and g = 1.11 ± 0.20 for the 150 keV state, $G_2\omega\tau$ = 0.073 ± 0.016 for a magnetic field of 12.8 kG and g = −0.16 ± 0.05 for the 1797 keV state. In the latter measurement the attenuation coefficient due to time-dependent perturbations was seen to be G_2 = 0.9 ± 0.1 by studying the anisotropy as a function of time by delayed coincidence technique. (auth)

42645 THE SPECTRUM OF INTERNAL CONVERSION ELECTRONS EMITTED DURING THE TRANSMUTATION OF ^{155}Sm INTO ^{155}Eu. Widemann, Francois; Sebille, Claire (CNRS, Orsay, France). Compt. Rend., Ser. A and B, 264: 1423-6(May 17, 1967). (In French).

The internal conversion spectrum emitted during the decay of ^{155}Sm into ^{155}Eu was studied using a semicircular magnetic spectrometer, with and without preacceleration, and provided with a screen permitting rapid renewing of the sources. 60 new rays were observed. Some multipolarities were given by measurement of the ratios $L_I/L_{II}/L_{III}$. (tr-auth)

42646 MULTIPOLARITY OF THE 501-keV TRANSITION OF ^{180}Hf. Gizon, Jean; Gizon, Andree (Faculte des Sciences, Grenoble, France). Compt. Read., Ser. A and B, 264: 1607-9 (June 5, 1967). (In French).

The ratios of the intensities of the internal conversion electron rays K/L = 2.28 ± 0.07 and $L_I/L_{II}/L_{III}$ = 206 ± 20/275 ± 25/100 entail an electric octupole nature for the 501-keV transition of ^{180}Hf. (tr-auth)

42647 THE HIGH-ENERGY γ RADIATION OF ^{106}Rh. Forest, Hugues; Huguet, Michel; Ythier, Christian (Faculte des Sciences, Nice). Compt. Rend., Ser. A and B, 264: 1614-17(June 5, 1967). (In French).

The γ radiation of ^{106}Rh was studied with a pair spectrometer using a germanium n-i-p diode as the central detector. Several

previously unreported γ rays were observed. The energy and relative intensity of these rays were indicated. The energy of several excited levels of ^{106}Pd could be made more precise. (tr-auth)

42648 ELASTIC SCATTERING OF POLARIZED 4-MeV NEUTRONS BY HEAVY AND MEDIUM-WEIGHT NUCLEI. Gorlov, G. V.; Lebedeva, N. S.; Morosov, V. M. (Atomic Energy Inst., Moscow). Phys. Lett., 25B: 197-9(Aug. 21, 1967).

The differential cross section for elastic scattering of polarized 4 MeV neutrons by ^{59}Co, ^{62}Ni, ^{80}Se, ^{93}Nb, ^{114}Cd, ^{115}In, ^{118}Sn, ^{127}I, natural Pb, and ^{209}Bi from 10 to 170° (the large-angle scattering experiment) and by Cu, In, Sn, Pb, Bi, and U from 2 to 21° (the small-angle experiment) was measured and compared with the results of a calculation with the optical model (with parameters chosen on the basis of the large-angle scattering data). Nuclear and Coulomb scattering alone is sufficient for the description of the small-angle scattering results. (auth)

42649 DIRECT NEUTRON CAPTURE IN ^{238}U(n,γ)^{239}U. Chrien, R. E.; Price, D. L.; Wasson, O. A.; Bhat, M. R.; Lone, M. A.; Beer, M. (Brookhaven National Lab., Upton, N. Y.). Phys. Lett., 25B: 195-7(Aug. 21, 1967). (BNL-11583).

Evidence for the presence of a direct reaction amplitude is presented for the neutron capture γ ray at 4.059 MeV in ^{238}U(n,γ)^{239}U. A cross-section interference analysis shows that the potential capture cross section for this γ ray is ~0.0016 barns at a neutron energy of 1 eV. (auth)

42650 THE (t,T) INTERACTION BETWEEN (d,p) AND (d,$\bar{n}$) CHANNELS AND THE ANOMALY IN (d,p) CROSS SECTIONS. Tamura, T. (Oak Ridge National Lab., Tenn.); Watson, C. E. Contract W-7405-eng-26. Phys. Lett., 25B: 186-9(Aug. 21, 1967). (ORNL-P-3223).

The anomaly of the ^{90}Zr(d,p)^{91}Zr cross sections at E_d = 7.05 MeV can be understood by considering the (t·T) interaction between the (d,p) and (d,$\bar{n}$) channels. (auth)

42651 PARITY-NON-CONSERVING INTERNUCLEON POTENTIALS STUDIES IN THE ^{113}Cd(n,γ)^{114}Cd REACTION. Warming, E.; Stecher-Rasmussen, F.; Ratynski, W.; Kopecky, J. (Danish Atomic Energy Commission, Risoe). Phys. Lett., 25B: 200-1(Aug. 21, 1967).

The asymmetry in the γ intensity after capture of polarized neutrons in ^{113}Cd was investigated. An upper limit to a possible asymmetry A was determined of $|A| < 4.7 \times 10^{-4}$. This result does not agree with that of Abov et al. (auth)

42652 CONTRIBUTION TO SUBCOULOMB STRIPPING: THE REACTION ^{116}Sn(d,n)^{117}Sb AT 6 MeV. Fuchs, H.; Grabisch, K.; Kraaz, P.; Roeschert, G. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Phys. Lett., 25B: 204-5(Aug. 21, 1967).

Energy and angular distributions of neutrons from the ^{116}Sn(d,n) ^{117}Sb reaction at E_d = 6 MeV were measured. The differential cross sections exhibit the same dependence on l typical for direct reactions above the Coulomb barrier. (auth)

42653 PERTURBED ANGULAR CORRELATION MEASUREMENTS WITH β-PARTICLES FROM ^{154}Eu. Nielsen, K. Bonde; Deutcher, B. I. (Univ. of Aarhus, Denmark). Phys. Lett., 25B: 208-10(Aug. 21, 1967).

It is demonstrated that the technique of perturbed angular correlations can be extented to the utilization of electrons. The sources were prepared by embedding ^{154}Eu into iron foil by means of an isotope separator. The perturbed angular correlation results for the 123 keV state in ^{154}Gd are consistent when obtained either by using the 1281γ−123γ or the 1855β−123γ cascade, for magnetization currents varying a factor of 15. The average ratio between the rotations of the correlation pattern is $\Delta\theta(\beta-\gamma)/\Delta\theta(\gamma-\gamma) = 0.96 \pm 0.10$ where $\Delta\theta(\gamma-\gamma) = 0.105 \pm 0.007$. Identical perturbed angular correlation determinations are possible with conversion electrons in an energy range ≳ 20 keV. Further results indicate that the apparent rotations for Gd and Lu in iron are similar and follow the estimated magnetization of the foil. The Lu has an effective internal magnetic field of 483 ± 60 kG in unannealed iron foil. (auth)

42654 ENERGY SPECTRA OF LONG RANGE PARTICLES FROM THE THERMAL NEUTRON FISSION OF ^{235}U. Dakowski, M.; Chwaszczewska, J.; Krogulski, T.; Piasecki, E.; Sowinski, M. (Inst. of Nuclear Research, Warsaw). Phys. Lett., 25B: 213-14 (Aug. 21, 1967).

Energy spectra of ^{1}H, ^{2}H, ^{3}H, ^{4}He, and ^{6}He from the thermal-neutron fission of ^{235}U were investigated using a semiconductor counter telescope and two-parameter analysis. Gaussian distributions were fitted to the measured distributions with the least-squares method. Relative intensities were calculated. (auth)

42655 YIELDS FOR THE A = 141 TO A = 153 REGION IN THE REACTOR NEUTRON FISSION OF ^{237}Np. Stella, Renato; Crespi, Vera; Maxia, Vera (Univ., Pavia, Italy). Ric. Sci., 37: 347-50 (Apr. 1967).

The yields of nine masses in the rare-earth region from the fission of ^{237}Np by reactor neutrons were examined in radiochemical studies utilizing ion-exchange chromatography. All irradiations were carried out with cadmium shielding in the central channel of a Triga Mark II reactor. The yields were determined and were compared with the corresponding yield of ^{235}U which was simultaneously irradiated. (auth)

42656 YIELDS FOR THE 131–135 MASS REGION IN THE REACTOR NEUTRON FISSION OF ^{237}Np. Stella, Renato; Di Casa, Michela; Maxia, Vera (Univ., Pavia, Italy). Ric. Sci., 37: 354-6(Apr. 1967).

The yields of ^{131}I, ^{133}I, ^{135}I, and ^{132}Te in ^{237}Np fission were determined radiochemically and compared with the corresponding yields for ^{235}U using ^{140}Ba as internal standard. All irradiations were carried out with cadmium shielding in the Triga Mark II reactor of the University of Pavia. (auth)

42657 ^{95}Zr, ^{97}Zr, AND ^{99}Mo YIELDS IN THE REACTOR NEUTRON FISSION OF ^{237}Np. Stella, Renato; Di Casa, Michela; Maxia, Vera (Univ., Pavia, Italy). Ric. Sci., 37: 357-9(Apr. 1967).

Fission yields of ^{95}Zr, ^{97}Zr, and ^{99}Mo were determined for the fission of ^{237}Np by neutrons from a Triga Mark II reactor using radiochemical techniques. All irradiations were carried out with cadmium shielding in the central channel of the Triga Mark II reactor of the LENA Laboratory, Pavia University. The relative yields of the fission-product nuclides were obtained by comparison of the fission-product activities from ^{237}Np with those formed from ^{235}U simultaneously irradiated. The values determined were: ^{95}Zr, 5.70%; ^{97}Zr, 6.04%; and ^{99}Mo, 6.78%. (auth)

42658 THE ENERGY DEPENDENCE IN THE RANGE 0.7 TO 4 MeV OF THE NEUTRON FISSION CROSS SECTION OF ^{239}Pu. Grama, N.; Marinescu, L.; Mihai, I.; Petrascu, M.; Sandulescu, A.; Voiculescu, G. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 12: 43-51(1967).

The energy dependence of the fission cross section of ^{239}Pu in the energy range 0.7 to 4 MeV was measured. The experimental points are compared with values calculated on the basis of many-level interference theory. (auth)

42659 SHIELDING OF RESONANCE REACTIONS IN ^{235}U AND ^{239}Pu BY ^{238}U. Carter, D. H.; Sanders, J. E. (Atomic Energy Establishment, Winfrith, Eng.). J. Nucl. Energy, 21: 565-75(July 1967).

Experiments were made to measure the shielding effect of ^{238}U resonances on epicadmium fissions in ^{235}U and ^{239}Pu. The experimental method is based on the comparison of detector reaction rates in cadmium-covered rods of depleted uranium and lead/^{235}U placed in the center channel of a subcritical assembly. The measured shielding factors are compared with the predictions of a simple theoretical model and reasonably good agreement is obtained. The influence of the resonance interaction on reactivity is considered and is shown to be small for a typical thermal reactor. (auth) (UK)

42660 A NOTE ON THE STRUCTURE OF THE 1518-keV ISOMERIC STATE IN ^{174}Yb. Kantele, J.; Liukkonen, E.; Sarmanto, A. (Univ. of Helsinki). Z. Phys., 204: 456-61(1967).

Studies of the decay of ^{174}Tm and ^{174m}Lu show that, in both cases, a level at 1517.6 ± 0.8 keV in ^{174}Yb is populated, which decays to the 4^+, 6^+, and 8^+ members of the ground-state rotational band. (auth)

42661 DECAYS OF ^{167} ^{165}Yb. Paris, Pierre (CNRS, Orsay, France). J. Phys. (Paris), 28: 388-400(May-June 1967). (In French).

Experimental results are given for the decays ^{167}Yb $\xrightarrow{17mn}$ ^{167}Tm and ^{165}Yb $\xrightarrow{10mn}$ ^{165}Tm. The corresponding level schemes are discussed. Comparison of the energies of similar intrinsic levels in four odd-A thulium isotopes suggests that their deformation decreases when the mass number increases. (auth)

42662 CONTRIBUTION TO THE STUDY OF ^{123}I DECAY. Sergolle, H.; Albouy, G.; Bouloumie, J.; Lagrange, J. M.; Marcus, L.; Pautrat, M. (Institut de Physique Nucleaire, Orsay, France). J. Phys. (Paris), 28: 383-7(May-June 1967). (In French).

Gamma rays from the decay of ^{123}I were studied with a Ge detector (resolution 4.5 keV). New transitions, with low intensity were found at the energies of 183, 192, 248, 538, 574, 624, 736, and 784

keV. These results, as well as γ-γ coincidence spectra suggest a level scheme of ^{123}Te with three new levels at energies of 697, 784, and 895 keV. (auth)

42663 REACTION CROSS SECTION ON ^{90}Sr FOR REACTOR NEUTRONS. Zeisel, G. Oesterr. Akad. Wiss. Math.-Naturwiss. Kl., Sitzungsber., 174: 575-89(1965). (In German).

The effective cross section of the reaction which transforms ^{90}Sr into ^{90}Y by means of reactor neutrons was measured using an ionization chamber in a compensation circuit. Since the activity of ^{90}Y in the measurements did not appear in the measurements, $\sigma \leq 50$ mb was estimated from the upper measurement limits of the effective cross section of a corresponding reaction. Spectra of irradiated Sr samples were taken for testing the purity of the ^{90}Sr solutions. In a measurement of an empty quartz tube irradiated in the reactor, the half life of ^{31}Si was determined as 2.62 ± 0.01 hr which is in good agreement with other published data. (tr-auth)

42664 HIGH-RESOLUTION STUDIES OF THE GAMMA RAYS FROM ISOMERIC STATES WITH HALF LIVES OF 10 μs TO 30 ms IN NUCLEI WITH Z = 63-83. Conlon, Thomas William. Princeton, N. J., Princeton Univ., 1966. 201p.

Thesis.

Isomeric states with half-lives between 10 μs and 30 ms in the region of atomic number Z = 63-83 were excited principally by the (p,n) and (p,2n) reactions, using 17.5-MeV protons. The characteristics of the gamma rays involved in the decay of the isomeric states were measured using a lithium-drifted germanium detector of volume 8 ccs. The resolution (FWHM) obtained for the full energy gamma ray peaks was limited by the associated electronics and was typically 5 keV. Nine new isomers were produced which have half-lives in the quoted range. For six of these, the isomeric nucleus was uniquely identified, and the multipolarities of the gamma rays involved were in most cases assigned. These isomeric nuclei and the measured value of the half-lives (in microseconds) are: ^{153}Gd, 75.8; ^{159}Dy, 122.3; ^{165}Tm, 80.3; ^{172}Lu, 434; ^{191}Pt, 107; ^{207}Bi, 174. The decay of the isomeric states in ^{159}Dy and ^{207}Bi give rise to particularly complicated spectra—in each case about ten gamma rays are involved. A unique scheme for the decay of the ^{159}Dy isomer was established; for the ^{207}Bi isomer, a level scheme was constructed which is consistent with the intensities and energies of the observed transitions. The remaining three new isomers were observed following bombardment of Gd, Hf, and ^{208}Pb; their respective half-lives are: 180, 6.1×10^3, 500 μs, and fourteen isomers, which have been previously reported, were excited in this work. The isomeric nuclei together with the half-life in microseconds are: ^{151}Eu, 62.7; ^{153}Tb, 190; ^{173}Lu, 87.5; ^{175}Hf, 54; ^{181}Ta, 22.0; ^{180}W, 5.53×10^3; ^{181}W, 16.0, ^{187}Os, 31; ^{187}Ir, 29×10^3; ^{189}Ir, 12.3×10^3; ^{199}Tl, 29.2×10^3; ^{200}Tl, 33×10^3; ^{201}Tl, 2.7×10^3; ^{206}Pb, 142. In almost all of these cases, the precision of the known transition energies and known half-lives were greatly improved; the multipolarities of the transitions involved and the identity of the isomeric nucleus were verified. The complicated decay schemes of the known isomers in ^{180}W and ^{189}Ir had not formerly been established. The energy of the isomeric states and the decay characteristics were determined here. The origin of the isomeric states are discussed principally in terms of the Nilsson model for odd-A nuclei. By considering the Nilsson states available to the last two particles, the isomerism in the even-A nuclei ^{172}Lu and ^{180}W can be understood. A state which may be described by Nilsson orbitals is suggested in order to explain the observed isomer in ^{159}Dy. Reduced matrix elements were extracted for the isomeric transitions and are examined to bring out possible systematic effects. (Disser. Abstr.)

42665 YIELDS FROM HIGHLY ASYMMETRIC FISSION: FRACTIONAL CUMULATIVE YIELDS OF ^{143}Ba, ^{144}Ba, AND ^{147}Ce FROM THERMAL-NEUTRON-INDUCED FISSION OF ^{235}U. Runnalls, Nelva E. Gross. Columbia, Mo., Univ. of Missouri, 1966. 70p.

Thesis.

Fractional cumulative yields of ^{143}Ba, ^{144}Ba, and ^{147}Ce from thermal-neutron-induced fission of ^{235}U were found to be 0.87 ± 0.04, 0.773 ± 0.035, and 0.96 ± 0.06, respectively. From the values obtained, together with previously measured yields, the width of the charge dispersions for masses 143 and 144 were found to be 0.59 ± 0.04 and 0.51 ± 0.03, respectively, in terms of the width parameter σ of the normal Gaussian curve. From the cumulative fractional chain yields, values of 55.92 for the mass-143 chain and 56.11 ± 0.04 for the mass-144 chain were calculated for the most probable nuclear charge (Z_p) of the primary fission fragment. The calculated values of Z_p differ from unchanged charge distribution in about the same amount as previously measured Z_p values in this region. The half-life of ^{144}Ba was found to be 11.9 ± 0.3 seconds. (Disser. Abstr.)

42666 CHARGE DISTRIBUTION IN THE FISSION OF ^{232}Th. Freid, Sheldon Henry. Tallahassee, Florida State Univ., 1966. 100p.

Thesis.

A radiochemical investigation of the charge distribution in the 9.5-MeV, 11.3 MeV proton and 11.5 MeV deuteron-induced fission of ^{232}Th was performed. Irradiations of thorium metal foils were carried out on the Florida State University Tandem Van de Graaff Accelerator and ten shielded and quasi-shielded nuclides were studied at each energy. The fractional yields of each of the nuclides were correlated with Z_p values derived on the basis of the ECD, MPE, and UCD prescriptions using both shell- and non-shell-affected mass equations. It was found that the ECD rule using shell-affected Z_A values gave the best correlation with a Gaussian expression of the form: $f_i = (1/\sqrt{c\pi})e^{-[(Z-Z_p)^2/c]}$, where c varied from 2 to 2.5 for the proton bombardment and varied from 1.0 to 1.5 for the deuteron bombardments. The results of this work were interpreted in terms of the average excitation energy at which fission occurred. Γ_n/Γ_f values were used to calculate the percentage of the total fission cross section at each stage in the de-excitation chain and the average energy was calculated from these values. An explanation is offered for the differences in the prescriptions which best correlate the charge dispersion data for proton and deuteron fission and those which best fit the alpha-induced fission of ^{232}Th. The average excitation energy for the alpha induced fission is higher than that for the proton or deuteron bombardments. For low average excitation energies, the ECD prescription fits the charge dispersion data best. As the average excitation energy increases the MPE prescription becomes more successful in interpreting the data. These same arguments are applicable in comparing the charge distribution data from the fission of ^{238}U to that from thorium fission. The Γ_n/Γ_f values are much larger for thorium and consequently produce a lower average excitation energy. (Disser. Abstr.)

42667 EXCITATION FUNCTIONS FOR THE HELIUM-ION-INDUCED FISSION OF RHENIUM, LUTETIUM, AND THULIUM. Raisbeck, Grant Miller. Lafayette, Ind., Purdue Univ., 1966. 171p.

Thesis.

The alpha-induced fission excitation functions of rhenium, lutetium, and thulium were measured in the energy interval of 30 to 80 MeV. The data extend considerably the range of elements studied at these energies, and are of particular interest since the nuclides involved are removed from the closed shell region. The experimental method is a "fission-track" technique, utilizing thin plastic films as detectors. Calibration of the system has permitted calculation of absolute cross sections. From the experimental cross sections, the ratio, Γ_f/Γ_n, which measures competition between fission and neutron emission, was calculated. The ratios were analyzed using a statistical model. The resulting fission thresholds for ^{189}Ir, ^{191}Ir, ^{179}Ta, and ^{173}Lu are 22.4, 23.6, 27.5, and 28.7 MeV, respectively. These results are obtained by assuming a level density parameter, $a_f = A/10$. The uncertainty in this choice introduces a possible error of ± 2.5 MeV in the absolute thresholds, although the relative values are probably more accurate. The results are compared with predictions of a recently proposed semi-empirical mass formulation based on a charged liquid drop and the agreement is within experimental error. Correlations are given showing the relation of Γ_f/Γ_n with Z^2/A and with E_f'-B_n', where E_f' and B_n' are the effective fission barrier and neutron binding energy. The results suggest that shell effects tend to persist even at excitation energies of 30 MeV. Comparisons of the correlations with heavy element data point out the marked discontinuity near Z = 90, and support the general two modes fission hypothesis. (Disser. Abstr.)

42668 FISSION PROPERTIES OF SOME ELEMENTS BELOW RADIUM. Khodai-Joopari, Arastoo. Berkeley, Calif., Univ. of California, 1966. 195p.

Thesis.

The fission cross sections σ_f were measured in bombardments of ^{209}Bi, ^{208}Pb, ^{207}Pb, and ^{206}Pb with helium ions of energies 25 to 130 MeV and ^{209}Bi, ^{208}Pb, ^{206}Pb, and ^{197}Au with protons of energy 15 to 30 MeV, using (mainly) mica for the detection of fission fragments. From the comparison of the low-energy σ_f/σ_R data with three different theoretical expressions for Γ_f/Γ_n, the heights of the fission barriers, B_f, for ^{213}At, ^{212}Po, ^{210}Po, ^{209}Bi, ^{207}Bi, and ^{198}Hg were deduced. The accuracies of the relative and the absolute values of B_f are 0.5 and 1.5 MeV, respectively. It is found that the ratio a_f/a_n is quite different (1.5 to 1.2) for these nuclei, indicating that the influence of shell effects on the level densities is still strong at moderately high excitation energies (≈16–40 MeV). A comparison of the relative values of B_f with the predictions of the conventional liquid-drop model seems to show that one obtains

somewhat better agreement if a composition-dependent surface energy is used. Therefore, the values of B_f are compared with those calculated by Myers and Swiatecki (M-S) which show fairly good gross agreement. However, the saddle masses plotted relative to the smooth liquid-drop reference mass surface of M-S show a structure similar to, but much less pronounced than, that corresponding to the ground-state masses. If this structure is taken as an indication for the existence of shell effects at the saddle point, the anomaly between the experimental and theoretical values of B_f for the heavy elements and the fission-barrier systematics can be qualitatively explained. A discussion is given of the possibility that shell effects at the saddle point may affect the interpretation of the observed features of low- and medium-energy fission, along with a brief review of some of the experimental observations and theoretical viewpoints in this connection. Various aspects of the higher-energy σ_f/σ_R data are qualitatively discussed. It is shown that within the framework of the Fermi gas model the level density parameter a_n has to increase with energy in order to account for the large discrepancy observed between the σ_f/σ_R data and the calculated values of $\Gamma_f/(\Gamma_f + \Gamma_n)$ extended to higher energies. Semiquantitative estimates of "first-chance" fission (for ^{212}Po and ^{211}Po) and of the numbers of prefission neutrons $\langle \nu_p \rangle$ are made and compared with estimates of $\langle \nu_p \rangle$ made by others in similar cases. The importance of such estimates for a correct interpretation of various distributions of fission fragments and the possibility of usefulness of these σ_f/σ_R data for a quantitative study of the behavior of level densities with energy is pointed out. (Disser. Abstr.)

42669 PROTON SCATTERING FROM NUCLEI WITH COLLECTIVE DEGREES OF FREEDOM. Stoler, Paul. New Brunswick, N. J., Rutgers–The State Univ., 1966. 124p.

Thesis.

Differential cross sections were obtained for 16-MeV protons elastically and inelastically scattered from ^{144}Sm, ^{148}Sm, ^{150}Sm, ^{152}Sm, ^{154}Sm, and ^{174}Yb vibrational and rotational states and were compared to the results of coupled-channel calculation. The results compare favorably. In addition, a theoretical description of the development of the coupled-channel formalism (as applied to the collective model) is discussed, and a fairly detailed discussion of the experimental apparatus and procedures is presented. (Disser. Abstr.)

42670 A STUDY OF THE INTERNAL-CONVERSION ELECTRONS EMITTED WITHIN THREE NANOSECONDS AFTER THE SPONTANEOUS FISSION OF ^{252}Cf. Watson, Rand Lewis. Berkeley, Calif., Univ. of California, 1966. 199p.

Thesis.

The spectra of internal conversion electrons of energies between 10 and 650 keV emitted in coincidence with the spontaneous fission of ^{252}Cf were measured and correlated to fragments of specific masses. A magnetic steering device was used to guide the electrons to a lithium-drifted silicon electron detector shielded against interference from fission fragments, alpha particles, gamma rays, and x rays. This device also made possible the measurement of the electron spectra in the specific time intervals of approximately 0 to 0.9, 0.1 to 1.7, and 1.1 to 2.9 nsecs after fission. The measured spectra showed well-defined structure and were analyzed by means of a least-squares peak-fitting procedure. Many of the lines were identified as K and L conversion line pairs, thus facilitating multipolarity assignments on the basis of K-to-L ratios. Estimates of intensities and half-lives are also given for a large number of the electron lines. By correlating the electron spectra with the gamma-ray measurements of Bowman, it was possible to assign many of the electron lines to specific isotopes. Several of the analyzed electron peaks were suggested as specific examples of possible 2+ to 0+ transitions in even-even nuclides. Two transitions thought to be associated with ^{110}Ru displayed energies and multipolarities that strongly suggest a region of stable deformation near mass 110. Binding-energy calculations were carried out employing a nonrelativistic Hartree-Fock computer program developed by Roothaan. The K and L binding energies of Sr, Pd, Xe, and Sm were calculated as a function of ionic charge ranging from the neutral atom to the fully ionized ion. It was found that the K and L binding energies are both increased over the neutral atomic values by approximately 0.9 keV for the most probable ionic charges of the fission fragments, and consequently that the K x-ray energies are almost unaffected. (Disser. Abstr.)

42671 ALPHA–GAMMA ANGULAR CORRELATIONS IN LIQUID SOURCES. Hutchinson, John Michael Robin. College Park, Md., Univ. of Maryland, 1966. 80p.

Thesis.

Angular correlations between alpha particles and gamma rays were measured in liquid sources of three separate nuclides, ^{243}Am, ^{233}U, and ^{237}Np. The experimentally determined angular-correlation functions had the following coefficients to the $P_3(\cos\theta)$ terms: ^{243}Am $\alpha-\gamma$ (74 keV), -0.36 ± 0.01; ^{233}U $\alpha-\gamma$ (45 keV), -0.02 ± 0.04; ^{233}U $\alpha-\gamma$ (99 keV), 0.18 ± 0.04; ^{237}Np $\alpha-\gamma$ (87 keV), 0.11 ± 0.04; ^{237}Np $\alpha-\gamma$ (29 keV), 0.25 ± 0.15. Relative alpha angular momentum mixing ratios, as deduced from the above transitions are, respectively, $+0.59 \geq (L = 2/L = 0) \geq 0.53$; $(L = 4/L = 2) \geq +0.05$; $(L = 4/L = 2) \geq +0.45$; $0.33 \geq (L = 2/L = 0) \geq +0.13$; and $(L = 2/L = 0) \geq 0.3$. The $(L = 2/L = 0)$ mixing ratios agree with theory, but the $(L = 4/L = 2)$ mixing ratios are somewhat higher than predicted. Upper limits of the half-lives of 99 keV and 45-keV states in ^{229}Th were measured, respectively, as 0.8×10^{-10} sec and 1.2×10^{-9} sec. From a comparison of the attenuated angular correlation in ^{243}Am and a previously measured angular correlation in ^{241}Am, it is deduced that an extranuclear interaction occurs whose time duration is less than 1.2×10^{-9} sec. (Disser. Abstr.)

42672 NUCLEAR SPINS OF ^{125}Cs AND ^{136}Cs; HYPERFINE STRUCTURE SEPARATIONS AND NUCLEAR MAGNETIC MOMENTS OF ^{125}Cs, ^{136}Cs, AND ^{127}Cs. Dabbousi, Osama Bashir. Berkeley, Calif., Univ. of California, 1966. 106p.

Thesis.

The nuclear spin and hyperfine-structure separation of (45-min) ^{125}Cs and (13-day) ^{136}Cs were measured. A more accurate value for the hyperfine-structure separation of (6.2-hr) ^{127}Cs was obtained by a least-squares fit of the previously observed resonances and the resonances observed. The nuclear magnetic moments of these isotopes were calculated from the hyperfine-structure separation with the use of the Fermi-Segrè formula. The isotopes ^{125}Cs and ^{127}Cs were obtained by the reactions ^{127}I(α,6n)^{125}Cs and ^{127}I(α,4n)^{127}Cs on elemental iodine. Barium iodide was also used as a target material in the early runs. Iodine or the barium iodide was separated out chemically after bombardment. Plots of the ratios of the activities obtained by bombarding iodine with α particles are given for the α-particle energy range from 63 to 118 MeV. The isotope ^{136}Cs was produced by the reactions ^{136}Xe(d,2n)^{136}Cs and ^{136}Xe(p,n)^{136}Cs on xenon gas with natural isotopic abundance. The activities collected on the buttons during a run were normalized by one of two methods: a hot wire monitored the resonance of the stable Cs carrier, and a side button collected the nonresonance atoms. Both procedures give a relative integrated flux of the beam from the oven during the exposure of a button. (Disser. Abstr.)

42673 THE GAMMA-RAY SPECTRUM OF ^{99}Ru. Moss, Gerald Allen. Eugene, Oreg., Univ. of Oregon, 1966. 146p.

Thesis.

The gamma-ray spectrum resulting from the decay of 16.1-day ^{99}Rh to the excited states of ^{99}Ru was investigated using Ge(Li) solid state detectors. The source, produced by the ^{99}Ru(p,n)^{99}Rh reaction using enriched ^{99}Ru metal, was found to emit a large number of gamma rays. The energies of the stronger gamma rays (with their relative intensities) are: 89.4 (100), 175.2 (7.6), 322.4 (21.7), 353.0 (107.1), 442.8 (5.7), annihilation radiation (30), 527.7 (132.0), 618.0 (13.1), 941.5 (5.0), 1292.1 (1.2), 1532.9 (1.8), 1572.4 (7.7) and 1970.3 (0.5)-keV. A number of lines not previously reported were found. Coincidence measurements and gamma-gamma directional correlations were performed using a 6 cc. Ge(Li) detector in conjunction with a gain stabilized NaI(Tl) spectrometer. The decay scheme was constructed with the aid of coincidence studies and high-precision gamma-ray energy measurements. The spin of the 618.0-keV level was shown to be $\frac{1}{2}$, whereas the results of the 89.4–353.0 and the 175.2–353.0 keV correlations indicate either a $\frac{1}{2}$ or $\frac{3}{2}$ assignment to the 442.8-keV level. Attempts to find a theoretical model which represents the experimental data were made, incorporating the Nilsson model, the intermediate coupling model of Bohr and Mottelson, and the core-excitation model of de Shalit. Of these the latter appears to be the most satisfactory representation. (Disser. Abstr.)

Nuclear Theory

Refer also to abstracts 41820, 42551, 42556, 42557, 42564, 42578, 42584, 42585, 42614, and 42711.

42674 (AD-645242) MODIFICATION OF THE EFFECTIVE PARTICLE-HOLE INTERACTION BY CORE POLARIZATION. de Takacsy, N. (California Inst. of Tech., Pasadena). Dec. 1966. Contract Nonr-220(47). 20p. CFSTI.

The second-order core-polarization corrections to the effective particle-hole force were calculated using a central potential with Rosenfeld exchange mixture. These corrections do not seem to seriously alter the spectrum of the particle-hole states of oxygen-16. (auth) (TAB)

42675 (AED-C-12-15-3) BIBLIOGRAPHIEN ZUR KERNFORSCHUNG UND KERNTECHNIK. SEKTION 12. OSTLITERATURE DER KERNWISSENSCHAFTEN. (Bibliographies in

Nuclear Science and Technology. Section 12. Nuclear Science Literature of Eastern Countries). Ensslen, Benno (comp.) (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). Mar. 1967. 259p. (In German and English). Dep.

References (1076) to literature dealing with Coulomb excitation; photonuclear reactions; reactions induced by electrons, deuterons, heavy ions, light nuclei, neutrons, protons, and tritons; and high-energy reactions are presented. Author and report-number indexes are included in an accompanying volume. (D.C.W.)

42676 (AED-C-12-15-4) BIBLIOGRAPHIEN ZUR KERNFORSCHUNG UND KERNTECHNIK. SEKTION 12. OSLITERATUR DER KERNWISSENSCHAFTEN. (Bibliographies in Nuclear Science and Technology. Section 12. Nuclear Science Literature of Eastern Countries). Ensslen, Benno (comp.) (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). Mar. 1967. 68p. (In German and English). Dep.

Author and report-number indexes for the accompanying bibliography of literature from eastern countries that deals with Coulomb excitation and nuclear reactions are presented. (D.C.W.)

42677 (IAE-1179) O PRYAMOM VOZBUZHDENII DELITEL'NYKH STEPENEI SVOBODY YADRA PRI NIZKIKH ENERGIYAKH. (On the Direct Excitation of the Fission of Nuclei at Low Energies). Vorotnikov, P. E. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). 1966. 16p. (In Russian). Dep.

The direct excitation of the fission of nuclei at low energies was calculated. The calculations showed the important effect of surface excitation as a result of the direct interaction of incident particles with the collective order of free nuclei in fission processes. The dividing width for nuclei with asymmetric deformation is at least two powers higher than for symmetrically deformed nuclei. The fission of symmetrically deformed nuclei occurs after its transition by asymmetric excitation. In such transitions the energy expended is ~1 MeV. Exchange with excitation between collective and monoparticle orders of the free nuclei is a comparatively slow process. The fission at $E^* \sim 6$ MeV remains below the barrier, and the permeability of the potential fission barrier $\sim 10^{-6}$. The height of the potential barrier is at least 2 MeV higher than that assumed previously. (tr-auth)

42678 (JINR-P4-3431) NEITRON-PROTONNYE KORRELYATSII V LEGKIKH YADRAKH. (N-P Correlations in Light Nuclei). Afanas'ev, G. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 24p. (In Russian). Dep.

The n-p correlations are treated by means of the Green functions method and generalized canonical transformations. It is shown that: the delay effects being taken into account do not change the non-superconductive character of the solution; the solutions with real (imaginary) correlation functions, identically different from zero, are energetically unfavorable; the following relation between phases of pp, nn, and np correlation functions should take place in general case: $\phi_{pp} + \phi_{nn}/2 - \phi_{np} = 0$; and in the case of charge symmetry (N = Z) the solution with identically vanishing np correlation function (for $\phi = 0$) is completely equivalent to the solution with the equal in modulus pp, nn, and np correlation functions (for $\phi = \pi/2$). (auth)

42679 (LA-DC-8950) A MODEL-BASED MASS LAW, AND THE r-PROCESS AS A MASS LAW TEST. Seeger, Philip A. (Los Alamos Scientific Lab., N. Mex.). [1967]. Contract W-7405-eng-36. 32p. (CONF-670818-1). Dep. CFSTI.

From 3rd International Conference on Atomic Masses, Winnipeg, Canada.

A mass law is presented, based on the liquid-drop model with shell and deformation corrections given by the Nilsson model and pairing energy by the Bardeen-Cooper-Schrieffer model. The resulting mass law has a total of 10 parameters, including all model parameters, and gives a standard deviation of 0.78 MeV when adjusted to the binding energies of 1127 known nuclei above mass 40. The r-process of nucleosynthesis is discussed and is shown to be relatively insensitive to all assumptions except the mass law. Results obtained using various mass laws are compared. (auth)

42680 (NP-16836) DETERMINATION DES ELEMENTS DE MATRICE NUCLEAIRES DE LA TRANSITION $2^- \rightarrow 2^+$, UNE FOIS INTERDITE, DU ^{84}Rb. (Determination of the Nuclear Matrix Elements of the First-Forbidden $2^- \rightarrow 2^+$ Transition of ^{84}Rb). Menet, Jacques (Grenoble Univ. (France). Laboratoire de Physique Nucleaire). Apr. 2, 1965. 64p. (In French). DTIE. Thesis.

The matrix elements of the first forbidden β transitions in ^{84}Rb were evaluated. A method more generally applied to all β transitions was used. Various experimental measurements and the formalism of β decay were employed. The results of the theoretical calculations were presented as quadratic forms of the matrix elements the coefficients of these quadratic forms can be determined numerically. By introducing experimental and theoretical data in a calculation program the matrix elements could be evaluated by means of a method which appears in the calculation of least squares. This procedure was applied particularly to the case of ^{84}Rb. Six nuclear matrix elements contribute to the decay of this nucleus. The experimental results used in the calculation were the spectra form, the directional correlation between β and the γ following the decay, the directional correlation between β and the circularly polarized γ, and the capture ratio by the nucleus of an electron of the K shell and of β^+ emission. The matrix elements were determined for two cases: consideration of the nucleus as a point and by the use of certain approximations and by taking into consideration the final shape of the nucleus. A study was then made to determine if the values of these matrix elements confirm simple predictions of the shell model. The agreement of the results with the theory of the preserved vector current was verified. This makes it possible to calculate the ratio of two particular matrix elements of the transition without formulating any hypothesis on the nuclear model. (J.S.R.)

42681 (NP-16946) UROVNI V SISTEME CHETYREKH NUKLONOV. (The Levels in the Four-Nucleon System). No. 502. Badalyan, A. M.; Gal'perin, E. S.; Lyakhovskii, V. N.; Pustovalov, V. V.; Simonov, Yu. A.; Surkov, E. L. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1967. 48p. (In Russian). Dep.

The four-nucleon wave-function is expanded for any spin and isotopic spin state as a series of K-harmonics - a complete set of harmonical angular functions in the nine-dimensional space. The Schroedinger equation then goes into a set of connected one-dimensional differential equations, which have the form of the two-particle Schroedinger equation. Keeping the lowest K for each spin-isospin state with a given angular momentum L one gets a single or two connected equations. The nineteen of these equations (the corresponding K = o, three K = I and fifteen K = 2) were solved numerically with two-nucleon potentials V_{13} and V_{31} of a square well, Yukawa and exponential form. The equation for K = O (S = T = L = O) gives two bound states: the ground and the excited state 0^+ of ^{4}He. The equations for K = I give no real states in this approximation, but are very close to being real. It is shown, that the bound energy values obtained in this method are the upper limits, that is taking the highest harmonics into account may only increase the absolute value of the binding energy. The Coulomb correction to the binding energy of ^{4}He and the variations of binding energy due to uncertainties in the parameters of the two-nucleons potentials are calculated. The n^4 state is absent even if the potential depth is strongly increased. The striking dependence of the binding energy on the potential form allows in principle to fix this form is the two-, three-, and four-nucleon systems are solved simultaneously. (auth)

42682 (RLO-1388-35) EXPERIMENTS ON ISOBARIC STATES IN NUCLEI. von Brentano, Peter (Washington Univ., Seattle. Nuclear Physics Lab.). July 1, 1967. Contract AT(45-1)-1388. 43p. (CONF-670433-1). Dep. CFSTI.

From Symposium on Nuclear Physics, Tbilisi, USSR.

A brief review is given on published literature dealing with isobaric analog states in medium and heavy nuclei. Discussions are presented on: isospin dependent effects in the form factor of bound states; experiments on delayed proton emission from analog states populated by direct reactions; nuclear structure information from resonant scattering through analog states; studies of particle-hole states via analog states; and spectroscopic factors. (S.F.L.)

42683 (UCB-34P141-8) THEORETICAL STUDIES OF NUCLEAR STRUCTURE AND TRANSITIONS. Progress Report for Year Ending September 30, 1967. Rasmussen, John O. (California Univ., Berkeley. Dept. of Chemistry). July 1967. Contract AT(11-1)-34. 54p. Dep. CFSTI.

An attempt was made to discover a relation between the energy and the spin of rotational states of deformed nuclei, and the accuracy of the quasi-boson method for calculating the seniority-one spectrum of a single-closed-shell spherical nucleus was studied. The seniority-one spectra of ^{89}Y and ^{90}Zr were calculated by direct diagonalization using a constant pairing force of adjustable strength, and the self-consistent description of nuclear structure was investigated. A quasiparticle model was formulated for odd-odd nuclei. Analyses of some spectroscopic experiments on the levels of ^{166}Ho, ^{140}La, and ^{142}Pr, in which (d,p), (n,γ), and (n,e$^-$) reactions were used, were performed. The problem of the Coriolis force for deformed nuclei was studied using the pairing plus quadrupole model. (D.C.W.)

42684 (UCRL-17725) TOWARD A THOMAS-FERMI MASS FORMULA. Myers, William D. (California Univ., Berkeley. Lawrence Radiation Lab.). Aug. 11, 1967. Contract W-7405-eng-48. 22p. (CONF-670818-2). Dep. CFSTI.

From 3rd International Conference on Atomic Masses, Winnipeg, Canada.

Nuclear properties--nuclear masses in particular-lend themselves to a two-part approach in which average properties and shell effects are treated separately. Recent improvements in treating the shell-effect part of nuclear masses have stimulated an investigation of corrections to the smooth part of the formula--the liquid-drop-model part. The Thomas-Fermi statistical method is employed to calculate these corrections, and the coefficient of the $A^{\frac{1}{3}}$ term is discussed in detail. In addition, the nuclear density distributions are shown which arise in the course of the Thomas-Fermi calculations. (auth)

42685 ELEMENTARY DERIVATION OF THE DENSITY OF STATES FUNCTION FOR CONTINUUM STATES. Phillips, G. C.; Griffy, T. A.; Biedenharn, L. C. (Rice Univ., Houston, Tex.). Z. Phys., 205: 420-4(1967).

The density of states function for continuum states in the presence of a nuclear Coulomb field is derived by the Sommerfeld-Weyl eigendifferential method. (auth)

42686 NUMERICAL PRECISE SOLUTIONS OF THE NONLOCAL SHELL MODELS. II. ENERGY LEVELS AND WAVE FUNCTIONS IN COMPARISON WITH LOCAL EQUIVALENT POTENTIAL SOLUTIONS. Krell, Max (Kernforschungszentrum, Karlsruhe, Ger.). Z. Phys., 205: 328-37(1967). (In German).

The nonlocal Schrödinger equation was solved in the shell-model case with a kernel function, which is well known from optical-model calculations. Now in the eigenvalue region, the energies, as well as the wave functions, of the exact and the approximate nonlocal calculations (E and E_0) differ slightly on the average. The exact solutions show in general larger energy-level distances. Although these differences are small, fitting of experimental neutron binding energies requires nevertheless a relatively big change of the set of physical parameters; the exact nonlocal calculations tend to larger potential depth V and smaller radius constant r_0 than the approximate nonlocal ones. For the wave functions (Φ and Φ_0), it can be shown that an application of the Perey effect leads to a wrong result in the shell-model case. Here the difference function shows two inflection points, whereas there is only one in the optical model. The form of nuclear matter distribution thus becomes more potential-like. The eigenfunctions of the exact nonlocal calculation are orthogonal, whereas the local-equivalent eigenfunctions are not. (auth)

42687 ANALYSIS OF ELASTIC DEUTERON SCATTERING BY NUCLEI, THE TENSOR SPIN-ORBITAL INTERACTION BEING TAKEN INTO ACCOUNT. Levshin, E. B. (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 12: 1125-35(July 1967). (In Russian).

Numerical calculations of the differential cross section, polarization, and all the components of the tensor polarization, as well as the complete section of the reaction under elastic scattering of deuterons with an energy of 11 MeV on the ^{40}Ca nucleus were made. By means of the analysis of the behavior of the calculated curve under the change of optical potential parameters a number of conclusions, necessary for the agreement of the theory with the experiment, can be made. A preliminary study of such dependences enables the experimenter to make a fitting procedure more reliable and effective. The effect of tensor forces on the angular distribution and all the types of polarization of elastically scattered deuterons is investigated. (auth)

42688 IS THE SURFACE OF THE NUCLEUS NEUTRON-RICH. Wilkinson, Denys H. Comments Nucl. Particle Phys., 1: 80-4 (Mar. 1967).

Several approaches to the problem of the structure of the nuclear surface are briefly discussed. These include charged pion scattering, capture of stopped K^- mesons, and neutron capture experiments. Present interpretation of these experiments tends to indicate a neutron-rich surface. (S.F.L.)

42689 NEW EXPERIMENTS AND IDEAS ON THE "VIBRATIONAL" NUCLEI. Bromley, D. A.; Weneser, J. Comments Nucl. Particle Phys., 1: 75-9(Mar. 1967).

A brief summary is given of the vibrational model of the nucleus, and the difficulty in using this model to account for the magnitudes of the 2^+ states of nuclei in the range $100 \leq A \leq 150$ is pointed out. It is suggested that the "sloppy" rotator-vibrator model proposed by Baranger and Kumar may be used to correct this difficulty. (S.F.L.)

42690 ISOBAR ANALOGUE STATES. Feshbach, Herman; Kerman, Arthur. Comments Nucl. Particle Phys., 1: 69-74 (Mar. 1967).

What isobar analog states are, how they can be produced, and how they may prove useful in nuclear spectroscopy are briefly discussed. (S.F.L.)

42691 CALCULATION OF NUCLEAR REACTION MATRIX ELEMENTS. Brink, David M.; Peierls, Rudolf E. Comments Nucl. Particle Phys., 1: 66-8(Mar. 1967).

The problem of calculating the properties of finite nuclei using interactions consistent with information derived from the two-nucleon problem involves singular short-range potentials and the two-body reaction matrix to describe the interaction of two nucleons in the nuclear environment. One of the major practical difficulties in applying this method is the solving of the equations for the reaction matrix. A brief review is given of some new techniques which have recently been used to solve the reaction matrix equation. (S.F.L.)

42692 CALCULATIONS OF PROPERTIES OF COLLECTIVE STATES OF DEFORMED NUCLEI WITH MASS NUMBER A LESS THAN 190 BUT GREATER THAN 176. Kalpazhin, M. K.; Fogel', P. (Joint Inst. for Nuclear Research, Dubna, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 2025-30(Dec. 1966). (In Russian).

Theoretical consideration of collective states of deformed nuclei is usually based on a microscopic model of the nucleus, in which nucleons move in a deformed average field, and interact with paired and multipole forces. It is important to take into account the change in deformation of the average field especially for nuclei with $176 < A < 190$. A modified scheme of single particle levels of the average field and characteristics of the ground states are listed for this region of masses. For each nucleus first the equations of the superfluid model of the nucleus were solved to determine the correlation function C and the chemical potential λ. The pair interaction constants were selected to obtain the best agreement between the experimental and theoretical paired energies. A secular equation for determining the frequency of the collective state was then solved. Most of the experimental data on collective states referred to gamma oscillatory states (states with $K^\pi = 2^+$). Good agreement between calculated and experimental values was obtained. A decrease in energies of states with $K^\pi = 2^+$ was observed with increasing number of neutrons and protons. Reduced probabilities B(E2) of electromagnetic transitions for Coulombic excitation of states with $K^\pi = 2^+$ were calculated with and without the blocking effect being taken into account. Collective states in the Re isotopes ^{183}Re, ^{185}Re, and ^{187}Re are discussed. A model with pair and multipole-multipole interactions explains the experimental data on collective states of nuclei with mass $176 < A < 190$. (TTT)

42693 USE OF POLARIZED DEUTERONS TO DETERMINE THE TOTAL ANGULAR MOMENTUM TRANSFER IN STRIPPING REACTIONS. Yule, T. J.; Haeberli, W. (Univ. of Wisconsin, Madison). Phys. Rev. Lett., 19: 756-9(Sept. 25, 1967).

A method for determining the total angular momentum transfer, and, hence, the spin of the residual nucleus, in stripping reactions was investigated. The vector analyzing power $P_d(\theta)$ was measured for a number of (d,p) reactions for which j and l had been previously determined. The dependence of $P_d(\theta)$ on j for a given l was investigated. (D.C.W.)

42694 AN ATTEMPT TO CALCULATE RADIATIVE CORRECTIONS TO A PURE FERMI DECAY. Kaellen, Gunnar (Univ. of Lund, Sweden). Acta Phys. Austr., Suppl. 4, 212-27(1967).

From 6th International Proceedings on Special Problems in High Energy Physics, Schladming, Austria, Feb. 26-Mar. 9, 1965. See CONF-670216.

A general survey is given of an attempt to estimate the effective value of the cutoff in the radiative corrections to nuclear β decay. (auth)

42695 ON NONMESONIC DECAYS OF K MESIC ATOMS. Wycech, S. (Inst. of Nuclear Research, Warsaw). Acta Phys. Pol., 32: 161-86(July 1967).

The question of the absorption of the atomic K mesons is studied. On the basis of the shell model, the impulse approximation and the semiphenomenological description of the KN and KNN interactions, the decay probabilities are calculated. The question of the short-range correlation functions is studied in connection with the two-nucleon absorption. The probabilities of the two-and one-nucleon captures are studied as functions of the nuclear model parameters. The relative probabilities of these two modes of decay, observed in the experiments, are explained in the case of light nuclei (auth)

42696 TWO-NUCLEON TRANSFER REACTION ON OXYGEN AND THE NUCLEAR COEXISTENCE MODEL. Doenau, F. (Central Inst. for Nuclear Research, Rossendorf, Ger.); Hehl, K.; Riedel, C.; Broglia, R. A.; Federman, P. Nucl. Phys., A101: 495-512(1967).

The experimental data of the reactions $^{16}O(t,p)^{18}O$ and $^{18}O(t,p)^{20}O$ are analyzed using the nuclear coexistence model for the description of the initial and final states. It is concluded that the admixture of deformed configurations in the nuclear states involved is essential to explain the observed relative cross sections. Two-particle transitions connecting deformed components do not carry, in general, any appreciable (t,p) strength. The main effect of the deformed state admixture is to provide destructive coherence in weakly excited final states. The detailed analysis of the relative cross sections for different levels provides information about the amplitude of the deformed component in the target ground state and the excited final states. Theoretical predictions are given for the reaction $^{18}O(p,t)^{16}O$. (auth)

42697 CALCULATION OF NUCLEAR STRUCTURE DIRECTLY FROM TWO-NUCLEON PHASE SHIFTS. Brink, David M.; Peierls Rudolf E. (Oxford Univ.). Comments Nucl. Particle Phys., 1: 146-50(July-Aug. 1967).

Methods used for the determination of nuclear properties from interaction potentials developed to fit two-nucleon scattering data at low and intermediate energies require rather elaborate computations. These methods require two laborious operations, first fitting potentials to the two-nucleon data via the determination of phase shifts, and second solving the problem of the interactions in a complex nucleus in terms of the potentials. The question is therefore briefly investigated of going directly from the nucleon–nucleon phase shifts to the interactions inside complex nuclei, thus avoiding much complication. (S.F.L.)

42698 THE EFFECTIVE CHARGE IN LIGHT NUCLEI. Wilkinson, D. H. (Oxford Univ.). Comments Nucl. Particle Phys., 1: 139-45(July-Aug. 1967).

The difficulties involved in interpreting the electric quadrupole (E2) transition in ^{17}O from the first excited state in terms of the shell model are reviewed. According to the shell model, the excited state is the closed-shell ^{16}O ground state with an orbiting $2s_{\frac{1}{2}}$ neutron, while the ground state is the same with the orbiting neutron in the $1d_{\frac{5}{2}}$ state. In this case the lifetime for the E2 transition would be extremely long since the quantum jump is made by the chargeless neutron. The experimental lifetime, however is very short, just as short as would be expected if the orbiting particle were a proton rather than a neutron. A similar phenomenon occurs in ^{18}O where the first excited state again behaves as though it had two protons outside a closed ^{16}O core rather than two neutrons. A brief discussion is given of a model which was designed in an attempt to resolve this conflict between experiment and theory. The model is based on a "tidal-wave" disturbance of the ^{16}O core which is induced by the orbiting neutrons and on assigning effective charges to the neutrons. (S.F.L.)

42699 NUCLEAR FORCES. I. Feshbach, H.; Kerman, A. K. (Massachusetts Inst. of Tech., Cambridge). Comments Nucl. Particle Phys., 1: 132-8(July-Aug. 1967).

The importance of nucleon–nucleon forces in the understanding of nuclear structure is reviewed, and the use of nucleon–nucleon scattering experiments to study these forces is briefly discussed. Results are outlined which have been obtained using incident nucleons with energies ranging up to approximately 350 MeV laboratory energy. The one-pion exchange potential is discussed. (S.F.L.)

42700 FINITE NUCLEAR SIZE EFFECTS IN INTERNAL CONVERSION. Pauli, Hans-Christian (Univ., Basel). Helv. Phys. Acta, 40: 713-44(Oct. 1, 1967).

The process of internal conversion including finite nuclear size effects is reanalyzed for an arbitrary multipole order. It can be shown that the dependence on nuclear structure can be described by two so-called nuclear parameters which are — for a specific nuclear transition — independent of the atomic subshells. These parameters may be determined by two or three conversion experiments and checked by others. New formulas for the particle parameter and for the conversion coefficients and their dependence on these nuclear parameters are derived. A recalculation of the conversion coefficients and particle parameters including all finite nuclear size effects has been performed as well as a comparison with the conversion coefficients as computed by Rose or by Sliv. The agreement with Sliv's values is generally better than with those of Rose. (auth)

42701 SINGLE-PARTICLE STATES IN NONLOCAL POTENTIALS AND DIRECT NUCLEAR REACTIONS. Schulz, H.; Wiebicke, J.; Reif, R. (Central Inst. of Nuclear Research, Rossendorf, Ger.). Nucl. Phys., A101: 577-88(1967).

The nonlocal model of Perey and Buck is extended to the bound-state problem. For ^{16}O and ^{40}Ca, the single-particle states in the nonlocal potential are compared with those in a local Woods-Saxon potential and with experiment. Different approximations for the nonlocal wave functions of bound and scattering states are tested and are found to be very useful. The influence of the nonlocality in zero-range DWBA calculations of the $^{16}O(d,p)^{17}O$ and $^{18}O(p,p')$ reactions is investigated. For the stripping reaction, the differential cross sections are compared with those obtained using a sharp radial cut-off. (auth)

42702 ANALYSIS OF THE DEUTERON BREAK-UP PROCESS INDUCED BY ALPHA PARTICLES. Nakamura, Hiroshi (Aoyama Gakuin Univ., Tokyo); Nagatani, K. Nucl. Phys., A101: 557-76(1967).

A theoretical analysis of the deuteron break-up process induced by alpha particles of a few tens MeV is presented. The final α-N interactions are studied on the assumption that α-N interactions can be described well by an empirical potential. The calculation of the final n-p interaction is carried out by the use of the zero-range approximation for the n-p interaction. The momentum representation and the technique of projection operators are adopted, and the matrix element is given in terms of one scalar S, two axial vectors V and A, and one symmetric Tensor T_{ij} with trace zero which may be the most convenient form for the numerical calculation. The deuteron pole terms are separated from the others in the matrix element for convenience in the investigation of the effects. The residual matrix element is analyzed by the use of the projection operators of the three-body exit channel reaction and an approximate formula which becomes exact in the neglect of the recoil of the alpha particle. (auth)

42703 RADIATIVE CAPTURE MECHANISMS IN HEAVY NUCLEI. Carlson, R. V.; Daly, P. J. (Purdue Univ., Lafayette, Ind.). Contract AT(11-1)-1672. Nucl. Phys., A102: 177-89 (1967). (COO-1672-3).

The known cross section data for radiative capture in heavy nuclei of 5 to 50 MeV nucleons and composite projectiles are summarized and the probable reaction mechanisms involved are discussed. Almost all the (α,γ) and (d,γ) results are shown to be in reasonable agreement with statistical theory predictions, especially when corrections for multiple γ-ray cascades and angular momentum effects are included. In particular, the variation of over two orders of magnitude in the reported (α,γ) maximum cross-sections are correctly predicted by statistical theory. To allow for the different nuclear penetrabilities of the various projectiles, each of the experimental capture cross section values has been divided by the appropriate optical model total reaction cross-section. The results provide strong support for the proposal that nucleon capture proceeds predominantly by direct or collective reaction mechanisms. Evidence that non-statistical processes make important contributions in the case of ^3He ion capture is also presented. It is concluded that there is no current evidence for mechanisms other than compound nucleus formation and decay in the radiative capture of deuterons and α-particles and that the projectile neutron/proton ratio has a marked effect on the probability of radiative capture. (auth)

42704 FIVE-DIMENSIONAL QUASI-SPIN: THE n, T DEPENDENCE OF SHELL-MODEL MATRIX ELEMENTS IN THE SENIORITY SCHEME. Hecht, K. T. (Univ. of Michigan, Ann Arbor). Nucl. Phys., A102: 11-80(1967).

The five-dimensional quasi-spin formalism is used to factor out the n, T dependent parts of shell-model matrix elements in the seniority scheme and derive reduction formulae which make it possible to express matrix elements for states of definite isospin T in the configuration j^n in terms of the corresponding matrix elements for the configuration j^v. The n, T dependent factors for one- and two-nucleon cfp and for the matrix elements of one-body operators and the two-body interaction are expressed in terms of generalized R(5) Wigner coefficients. The needed R(5) Wigner coefficients are calculated in the form of general algebraic expressions for the seniorities v and reduced isospins t corresponding to the simpler R(5) irreducible representations. In this first contribution, the R(5) representations $(\omega_1 t) = (j + \frac{1}{2} - \frac{1}{2}v, t)$ are restricted to $(\omega_1 0)$, $(\omega_1 \frac{1}{2})$, (tt), and the states of $(\omega_1 1)$ with $n - v = 4k - 2T$, (k is an integer). Explicit expressions are given for the diagonal matrix elements of the general, charge-independent, two-body interaction and the isovector and isotensor parts of the Coulomb interaction for seniorities $v = 0$ and 1, and the $v = 2$ states with $n = 4k + 2 - 2T$. (auth)

42705 CENTER-OF-MASS SPURIOSITY AND HARTREE–FOCK CALCULATIONS. Federman, P.; Giraud, B.; Zaikin, D. (Univ. of Copenhagen). Nucl. Phys., A102: 81-91(1967).

The problem of spurious states in Hartree–Fock calculations is defined as stemming from the lack of factorization of a general Slater determinant between center-of-mass and internal motions. A harmonic oscillator ground state motion is chosen for the center of mass, and maxima and minima deviations from this freezing are computed for practical cases of particle-hole Slater determinants on ^{16}O, ^{40}Ca, ^{120}Sn and ^{208}Pb cores. (auth)

42706 TRANSFER REACTION WITH HEAVY IONS. Perrenoud, Jean-Luc; Sheldon, Eric (Eidgenossische Technische Hochschule, Zurich). Nucl. Phys., A102: 105-28(1967). (In French).

The neutron transfer process in heavy-ion reactions is treated in accordance with Coulomb T-matrix (CTM) theory. On the basis of the Greider formalism, formulae giving differential and total cross sections in absolute magnitude are derived. Stress is laid upon appropriate normalization and nuclear structure considerations. The off-energy-shell contributions to the Coulomb T-matrix are therein treated in first approximation, resolving the originally incorrect energy dependence of the cross sections. The calculated angular distributions and excitation functions are in good agreement with the available data for energies well below the classical Coulomb barrier. Reduced widths are determined in good agreement with those derived on the assumption that a square potential well binds the transferred neutron to each of the heavy nuclei. The formalism is compared throughout with commensurate expressions derived from a DWBA treatment of the reaction. The CTM results are also applied to a case involving transfer of angular momentum along with the neutron; the theoretical predictions are compared with recent experimental data. For energies in the vicinity of the top of the Coulomb barrier, an attempt to integrate the transition amplitude analytically is described. This makes use of a simple cut-off model to account for the effects of absorption due to the nuclear potentials; although the angular distributions tally with measured values, the model proves inadequate to reproduce the observed magnitudes and energy dependence of the absolute cross sections. (auth)

42707 CONTRIBUTION OF UNPAIRED PARTICLE TO THE DEFORMATION OF THE NUCLEUS. Berlovich, E. E.; Novikov, Yu. N. (Ioffe Inst. of Physics and Tech., Leningrad). JETP Lett. (USSR) (Engl. Transl.), 5: 334-6(June 1, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 5: 410-12(June 1, 1967).

The contribution of the odd particle to the deformation of the nucleus was investigated by calculating the equilibrium deformations of even-even and odd nuclei for which experimental values of the quadrupole moments were available. (D.C.W.)

42708 POLYSPEC: A COMPUTER PROGRAM TO RESOLVE COMPLEX GAMMA-RAY SPECTRA FROM SAMPLES OF DIFFERENT DENSITIES. Lloyd, R. D.; Christensen, J. A.; Church, B. W.; Fisher, P. S.; Mays, C. W.; Pendleton, R. C. (Univ. of Utah, Salt Lake City). Health Phys., 13: 851-5(Aug. 1967).

A computer program has been developed which can be used to resolve gamma spectra from samples containing a number of radionuclides by the method of simultaneous equations. No restriction as to the number or identity of gamma emitters is imposed by the program. It is designed to utilize data from samples of any density from 0.1 to 1.0 g/cm^3 and will calculate radionuclide concentrations corrected for the effect of density on counting rate. (auth) (UK)

42709 NATURE OF SELF-CONSISTENT SOLUTIONS FOR ^{20}Ne AND ^{24}Mg. Parikh, J. C. (Univ. of Copenhagen). Phys. Lett., 25B: 181-3(Aug. 21, 1967).

A number of self-consistent solutions are shown to exist for ^{20}Ne and ^{24}Mg. In ^{24}Mg, some of these lie very close in energy to the one previously obtained by Kelson. The structure of the Hartree–Fock field is examined. (auth)

42710 SOLUTION OF THE NUCLEAR HARTREE-FOCK EQUATIONS IN COORDINATE SPACE. Vautherin, D.; Veneroni, M. (Institut de Physique Nucleaire, Orsay, France). Phys. Lett., 25B: 175-8(Aug. 21, 1967).

A method is proposed to solve directly the Hartree–Fock integro-differential equations for spherical nuclei. The iteration process requires only the solution of Schrödinger equations with a local but state-dependent potential. Numerical results are given for ^{16}O and ^{40}Ca. (auth)

42711 CALCULATION OF SPECTRA BY THE STRETCH MODEL. Raynal, J. (CEN de Saclay, Gif-sur-Yvette, France). Phys. Lett., 25B: 173-4(Aug. 21, 1967). (In French).

A tensor expansion of the two-body force gives directly the spectrum of a rotational band described by the stretch scheme within the approximations used by Danos and Gillet. Exact calculations show that these approximations are remarkably accurate up to half-filled shells. (auth)

42712 ANALYSIS OF TRIPLE CORRELATIONS IN RADIATIVE CAPTURE REACTIONS. Kresnin, A. A.; Storizhko, V. E. (Atomic Energy Establishment, Cairo). Z. Naturforsch., 22a: 1131-2(July 1967).

The advantages of applying a geometry in which the primary γ-quantum is detected in the beam direction in the study of triple angular correlations in radiative capture reactions is discussed. The technique may be applied to practically all the reactions of radiative capture, whereas former methods are limited. Another attractive feature of the method is that the decaying state does not necessarily have to be a state with well-defined spin and parity, which allows the use of thick targets in practice. (S.F.L.)

42713 INVESTIGATION OF ATOMIC NUCLEI WITH THE AID OF POLARIZED NEUTRONS. Schirmer, G.; Pose, H. (Technische Univ., Dresden). Kernenergie, 10: 186-9(June 1967). (In German).

The polarization efficiency of atomic nuclei for elastically scattered neutrons is often dependent on energy in a composite manner. In the region of a narrow resonance of the total scattering cross-section peaks of polarization may appear the width of which is smaller than the spectrum of the incident particles. For studying polarization effects in such cases, the left-right asymmetry was determined in connection with the analysis of the energies of the particles scattered. This technique was applied for studying ^9Be and ^{12}C with D-D neutrons. Thus, large energy variations of the scattering asymmetry were found in the energy range given by the neutron spectrum. (auth)

42714 THE PRIMARY EXTINCTION AT RESONANT SCATTERING OF γ-RAYS. Mospanov, V.S. (Moscow Inst. of Engineering Physics). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 4, 62-5(1967). (In Russian).

A generalized expression was obtained for the length of primary extinction of nuclear scattering. During resonant scattering the length was shorter by order of two than in nonresonant scattering. (tr-auth)

42715 EXACT NUMERICAL SOLUTION FOR THE NONLOCAL SHELL MODEL. I. TREATMENT OF INTEGRO-DIFFERENTIAL EQUATIONS FOR BOUND STATES. Krell, Max (Kernforschungszentrum, Karlsruhe, Ger.). Z. Phys., 205: 272-90(1967). (In German).

Nonlocal potentials can in general be transformed only approximately into local potentials with additional energy dependence. For the optical model, Perey and Buck did an exact nonlocal calculation with the Schrödinger equation in integro-differential form and also a good local approximation. Certain systematic deviations in the results (concerning the wave functions) of both processes are of special interest in the shell model. Therefore the eigenvalue problem has been solved now with the most successful nonlocal potential, also used by Perey and Buck, both exactly and approximately, that is with the potential, which is nondiagonal, and its approximation, which is diagonal in local space. The solution of this approximate nonlocal potential serves again as the zero-order starting value (E_0, u_0) for an interation process, which now is twofold, in order to find that exact solution (E, u). Thus, together with the exact solution, the deviation of the approximate nonlocal (local-equivalent) solution is also obtained. (auth)

42716 COMMENTS ON CALCULATIONS OF FAST NEUTRON ACTIVATION CROSS SECTIONS. Grench, H. A. (Lockheed Missiles and Space Co., Palo Alto, Calif.). J. Nucl. Energy, 21: 577-80(July 1967).

The basis of the calculations of Naguib and Lukyanov [J. Nucl. Energy, 20: 373-5 (1966)] for cross sections above 0.5 to 2 MeV is questioned, and an alternative method of calculation is presented. (UK)

42717 EXPERIMENTAL STUDY OF (n,γ) REACTIONS. Kiss, Dezso (Central Research Inst. for Physics, Budapest). Magy. Fiz. Foly., 15: 213-70(1967). (In Hungarian).

The excited nuclei formed in (n,γ) reactions possess an excitation energy of 7 to 10 MeV, corresponding to the bonding energy of neutrons. This energy is released by one or several cascade-type γ quanta. The overall problem was reviewed, limiting it, however, to the capture of thermal or epithermal neutrons and the γ spectroscopic study of the reaction. It is pointed out that in addition to the formation of an intermediate nucleus and the direct mechanism, the Feshbach doorway mechanism which occupies a central position between the two, is of great theoretical interest. It is concluded on the basis of accumulated evidence that the mechanism of the (n,γ)

reactions is more complex than it was previously assumed. (192 references. (TTT)

42718 STATISTICAL ERRORS IN POSITRON EMISSION PROBABILITY DETERMINATIONS BY COINCIDENCE METHOD. Vatai, Endre. ATOMKI (At. Kut. Intez.) Kozlem., 9: 95-7(June 1967). (In Hungarian).

Statistical errors in positron emission probability determinations indicate that the coincidence and singles counts are statistically not independent. (auth)

42719 UNIFIED MODEL FOR THE NUCLEI ^{201}Tl, ^{198}Hg, AND ^{197}Au. Ialongo, Gilberto. New York, New York Univ., 1966. 190p.

Thesis.

The low-energy nuclear properties of ^{201}Tl, ^{198}Hg, and ^{197}Au are analyzed by using the theory of the intermediate coupling approach in the unified nuclear model. The ^{201}Tl, ^{198}Hg, and ^{197}Au nuclei are considered to consist of an even-even lead core plus proton-holes which are assumed to have available the $s_{1/2}$, $d_{3/2}$, $h_{11/2}$, and $d_{5/2}$ single-hole shell-model states. The proton-holes are subject to a pairing force and are coupled to the quadrupole vibrations of the surface of the even-even core of the Pb isotopes. Different cases are considered: the simplest involves the $s_{1/2}$ and $d_{5/2}$ single-hole states and all states with up to two quanta of vibration; the most complex involves all the single-hole states and all states with up to three quanta of vibration. The Hamiltonian of the coupled system is diagonalized in the space of the basis eigenvectors of the uncoupled system for different values of the coupling strength. Good agreement with the experimental data is obtained for values of the coupling parameter a = .6 MeV for ^{201}Tl and ^{198}Hg and for a = .5 MeV for ^{197}Au. Diagonalizations performed with the pairing strength set equal to zero show that the effects of the pairing force are less important than those of the quadrupole force. The wave-functions obtained from the model are used to calculate the electric and magnetic transition probabilities between the low-lying states, as well as the electric quadrupole and magnetic dipole moments. The agreement with the experimental data is quite good, but the magnetic dipole moments of gold can not be accounted for satisfactorily. (Disser. Abstr.)

42720 INTERNAL IONIZATION DURING BETA DECAY. Stephas, Paul. Eugene, Oreg., Univ. of Oregon, 1966. 103p.

Thesis.

In nuclear β decay, atomic excitation including ionization can occur due to the sudden change in nuclear charge and imperfect overlap of parent and daughter orbital-electron wave functions, and scattering of atomic electrons by the β particle ("direct collisions"). In order to evaluate the relative importance of these two processes and test the possible role of nuclear matrix elements in orbital-electron ejection, the probability of K-ionization in β decay of ^{99}Tc, and ^{147}Pm, was measured. The total probabilities are $4.8 \pm 0.3 \times 10^{-4}$ and $9.3 \pm 1.4 \times 10^{-5}$ per beta, respectively. The number of K x rays in coincidence with β particles in a given energy interval has also been measured, in order to determine the K-ionization probability as a function of β-particle energy. A strong β-energy dependence is found. The present results for the total ionization probability, as well as measurements of this quantity performed by others, agree well with theoretical predictions based on imperfect wave-function overlap. However, the traditional theory based on this mechanism yields an ionization probability that is independent of β-particle energy, in clear disagreement with the present experimental results. The direct-collision theory, on the other hand, does lead to a β-energy dependent ionization probability, in qualitative agreement with the observed differential probability. However, the agreement of measured total ionization probabilities with the predictions of the wave-function overlap theory makes it appear unlikely that direct collisions should provide the dominant mechanism for bound-electron ejection. Therefore, the wave-function overlap theory was reexamined. It is shown that inclusion of proper phase-space considerations in this theory does lead to a β-energy dependence of the ionization probability and yields predictions that are in fair agreement with experiment. (Disser. Abstr.)

42721 MODES OF MOTION OF ODD-MASS SPHERICAL NUCLEI. Sherwood, Arnold Ira. San Diego, Calif., Univ. of California, 1966. 148p.

Thesis.

The low-lying states of an odd-mass spherical nucleus are considered as arising from the coupling of in independent-particle mode to an even vibrating core. The method of treatment proceeds from a consideration of the equation of motion of the independent particle. This yields a set of coupled linearized equations for the amplitudes of excitation of the states of the odd-mass nucleus with respect to those of the even core, which is expressed in matrix form. In order to ensure that this matrix is Hermitian (in contrast to the second random phase approximation), the problem is formulated so that only amplitudes of single excitation appear. This is accomplished by employing an expansion in terms of a complete set of states of the even core. The method is first developed for the nonnormal-parity states of odd-mass nuclei with doubly closed shell cores. The states of the core are treated by the hole-particle random phase approximation (RPA) method. Numerical calculations are carried out for the case of ^{17}O, employing the same finite-range central exchange force used by Gillet for ^{16}O. The most important result found is that no single phonon-coupled or single-particle state occurs below 5 MeV of excitation. The odd-mass nuclei with doubly open shell cores are then studied. The independent-particle mode of motion in these regions of the periodic table is that of quasi-particles. These are obtained by means of the Bogolyubov-Valatin transformation. A calculation of the pairing effects in ^{58}Ni is presented, which essentially agrees with the simple pairing-force treatment. The states of the core are again treated by RPA. This method is called extended quasi-particle-phonon coupling (EQPC), as it can be regarded as an extension of the usual quasiparticle-phonon coupling (QPC) through the inclusion of the 'backward-going' amplitudes. Numerical calculations, based on the pairing plus quadrupole force effective Hamiltonian, show that the effects of 'backward-coupling' are very pronounced in the odd-mass isotopes of Tc, Rh, Ag, Se, and Zn. This mechanism seems to provide an explanation for the occurrence of low-lying phonon-coupled levels in these nuclei. A self-consistent method is then developed which does not assume a quasiparticle basis (i.e., the treatment of short-range correlations first). This may be useful in regions where the quadrupole phonon state appears too close to the ground state, causing large fluctuations of the quasiparticle states due to the long-range correlations. A similar self-consistent treatment may be necessary for the case of pairing vibrations, arising from fluctuations of the pairing field. A method is presented for this case, and its possible application to nuclei such as ^{206}Pb discussed. (Disser. Abstr.)

42722 COUPLED CHANNELS AND THEIR APPLICATION TO RESONANCES IN THE SCATTERING OF LOW-ENERGY NEUTRONS BY ^{12}C. Roeder, John Louis. Princeton, N. J., Princeton Univ., 1966. 196p.

Thesis.

The importance of channel coupling in nuclear reactions is discussed, and the coupled Schrödinger equations solved in many-channel calculations of nuclear reactions are formulated. Their solutions are discussed in detail, particularly from the viewpoint of the transition and reaction matrices. Coupled-channel computer calculations are presented for low-energy neutron scattering by ^{12}C and for other examples of more general interest, in which resonances are investigated from the viewpoints of scattering cross sections, phase shifts, and poles of the transition matrix. Many of these resonances are seen to arise from channel coupling. Wherever possible, the results of our calculations are compared with analytic results which have been obtained only for special cases. Our concluding analysis includes a discussion of the behavior of resonances near channel thresholds. (Disser. Abstr.)

REACTOR TECHNOLOGY

Central Power Reactors

Refer also to abstracts 40932, 40954, 41097, 41127, 41128, 41292, 41627, 41679, 41851, 42523, 42524, 42811, and 42812.

42723 (AI-CE-43) HEAVY WATER ORGANIC COOLED REACTOR. EXP-NRU-305 EXPERIMENT DESIGN AND IRRADIATION. Culley, G. E.; LeBlanc, J. G.; Lillie, A. F. (Atomics International, Canoga Park, Calif. Combustion Engineering, Inc., Windsor, Conn. Nuclear Div.). Sept. 15, 1967. Contract AT(38-1)-430. 89p. Dep. CFSTI.

The initial fuel irradiation test of the HWOCR program, designated the EXP-NRU-305, was designed to establish the irradiation performance capabilities of the reference and backup for UC and UO_2 fuels for the HWOCR under conditions representative of HWOCR design. The irradiation test was conducted in the organic cooled U-3 loop of the NRU reactor at Chalk River, Canada, between July 1965 and April 1966. The fuel string consisted of three 18-rod clusters of SAP clad hyperstoichiometric UC and two 18-rod clusters of Zircaloy-4 clad UO_2, mounted in tandem. The UC portion was designed to operate at a peak specific power of 40 kw/kgU at an initial central fuel temperature of 2000°F, with a cladding temperature of 850°F. The UO_2 portion of the string was designed to operate with a maximum temperature of the cored-UO_2 pellets of 3000°F, and a cladding surface temperature of 820°F. The experiment coolant was Santowax OM with 20% high boiler compounds at a nominal 600°F temperature and a 30 ft/sec velocity in the test section. The irradiation test was terminated on April 16, 1966, following 263 days in-pile and 206 days at the design string power of 1.7 Mw, as a result of the release of rare fission gases from the rupture of several Zircaloy 4 clad UO_2 rods. At the time of discharge, the peak UC burnup was approximately 10,000 Mwd/MTU, and the peak UO_2 burnup approximately 8500 Mwd/MTU. During the irradiation test, fuel string cladding temperatures, coolant temperatures, test assembly hydraulic and coolant chemical characteristics were closely monitored. Analysis of operating characteristics indicated in general that the string operated in a stable manner during its irradiation with an increase in string hydraulic pressure drop of about 10%, and with formation of a heat transfer surface film with a maximum thickness of approximately 0.002 in. Calculated film thicknesses were corroborated by postirradiation examination. (auth)

42724 (AI-CE-56) HEAVY WATER ORGANIC COOLED REACTOR. Quarterly Technical Progress Report, October-December 1966. (Atomics International, Canoga Park, Calif. Combustion Engineering, Inc., Windsor, Conn. Nuclear Div.). Aug. 15, 1967. Contract AT(38-1)-430. 243p. Dep. CFSTI.

Items of significant technical progress are reported for the HWOCR development program. Specific projects described are: Reactor Physics, Reference Plant Engineering, Dual Purpose Plant Engineering, Dual Stream Reactor Concept, Pressure Tube, Transition Joints, Pressure Tube Fabrication Development Reactor Control Systems, Fuel, Organic Coolant Evaluation and Analytical Techniques, Parameters Affecting Film Formation, Coolant Technology Loop, and On-Power Refueling. (H.D.R.)

42725 (ANL-7357) REACTOR DEVELOPMENT PROGRAM PROGRESS REPORT, JULY 1967. (Argonne National Lab., Ill.). Aug. 31, 1967. Contract W-31-109-eng-38. 148p. Dep. CFSTI.

EXPERIMENTAL BOILING WATER REACTOR—reactivity worths of boric acid and nine-rod shim bank
REACTIVITY—worth measurements of boric acid and nine-rod shim bank in EBWR; worths of EBR-2 control rods, measured and calculated values of; coefficient measurements in ZPR-3
EXPERIMENTAL BREEDER REACTOR-II—operations history for July 1967; control element subassemblies for, fabrication of; control elements for, design of instrumented subassembly; fuel elements for unloading machine for; instrumentation for, modifications of; control rods for, measured and calculated reactivity worth of; hydraulic and thermal analyses for; safety systems for, testing of; operation of, analysis of high power; coolant for, chemical analysis of primary; experiment irradiations in, tabular summary of; structural materials for, radiation damage in
REACTOR CONTROL ELEMENTS—fabrication of instrumented subassemblies for EBR-2; reactivity worths of EBR-2, measured and calculated
SODIUM—loop and cell of chemical analysis of radioactive; purification of, modifications of loops for; sampling for quality control of primary coolant; corrosion inhibition in liquid-, use of getters for
REACTOR FUEL ELEMENTS—development of EBR-2 modified; trace element effects on swelling behavior of; burnup analysis of fast; fission yields for fast; radiation effects on uranium-plutonium; performance of mixed oxide and cermat; radiation effects on mixed carbide; claddings for, fabrication of vanadium-chromium-titanium alloys for; conductivity of irradiated, measurement of thermal; diffusivity of irradiated, measurement of thermal
FISSION PRODUCTS—determination in sodium coolant; distribution in irradiated mixed oxide fuels of gamma-emitting
REACTOR FUELS—cycle facility for, operation of; fission products in irradiated mixed oxide, distribution of gamma-emitting; vaporization of; sublimation of, enthalpy of
CRITICAL ASSEMBLIES—perturbation measurements in ZPR-3, use of fissionable materials for; perturbation measurements in ZPR-3, use of boron and tantalum for; flux measurements in ZPR-6, adjoint; Doppler effect measurements in ZPR-9
REACTORS, FAST—fuel elements for, burnup analysis of; fuel elements for, fission yields from; fuels for, development of reprocessing techniques for; physics parameters for, analysis of single-core-zone; core structural dynamics for; fuel elements for, meltdown studies in TREAT; coolant dynamics for sodium-cooled
CORROSION LOOPS—oxygen analysis in sodium-nickel mass transfer; carbonate analysis in sodium-nickel mass transfer
NEUTRON CROSS SECTIONS—measurement of $^{21}Ne(n,\alpha)^{18}O$, data for titanium and vanadium, evaluation of
NEUTRONS, THERMAL—cross section measurements for $^{21}Ne(n,\alpha)^{18}O$
NEUTRONS, EPITHERMAL—resonance integrals, calculation of
URANIUM—USO, phase studies on solid solutions of; recovery from low-enrichment fuels of, fluoride volatility process for
LOOPS—modification of sodium purification
CESIUM—separation of from primary sodium of radio-
THERMOCOUPLE—development of high temperature fuel-pin
FLOWMETERS—development of in-core
TRANSDUCERS—development of fission-gas pressure
VANADIUM ALLOYS, CHROMIUM ALLOYS, TITANIUM ALLOYS—V-Cr-Ti-base, fabrication for fuel element cladding
ULTRASONIC INSPECTION—elastic moduli of high temperature materials using, determination of
REMOTE-HANDLING EQUIPMENT—development of electric master-slave
HEAT TRANSFER SYSTEMS—measurements for liquid-metal cooled reactors in
MAGNETO HYDRODYNAMIC CELLS—injectors for, analysis of condensing
STRESS—calculations of anisotropic thermoelasticity for analytical use
PLUTONIUM—recovery from low-enrichment fuels of, fluoride volatility process for
REACTOR SAFETY EXPERIMENTS—fuel meltdown studies in TREAT, fast reactor
HEAT TRANSFER—pressure generation due to fuel meltdown in sodium, analysis of
REACTORS, LIQUID-METAL COOLED—coolant dynamics for fast
SULFUR—USO, phase studies on solid solutions of
OXYGEN—USO, phase studies on solid solutions of (M.L.S.)

42726 (IITRI-578P21-30) STUDIES OF REACTOR CONTAINMENT. Progress Report, June-July 1967. Gallagher, E. V. (IIT Research Inst., Chicago, Ill.). Contract AT(11-1)-578. 26p. Dep. CFSTI.

An analysis and summary of pressures in the air-filled driven section of the water shock tube are discussed. The performance of experiments using the twelve-foot-long driver section is discussed, but only initial results are available. The data analyzed for the air pressures consist essentially of experimentation with the six-foot-long driver section. The experiment is a simple representation of the primary coolant loop and the containment vessel of a prototype nuclear power reactor. (J.C.W.)

42727 (KFK-586) PROGRAM, PIN DESIGN, AND SPECIFICATIONS FOR FUEL IRRADIATION EXPERIMENTS IN THE ENRICO FERMI FAST BREEDER REACTOR. Karsten, G.; Kummerer, K. (comps.) (Kernforschungszentrum, Karlsruhe

(West Germany). Institut fuer Angewandte Reaktorphysik). May 1967. 69p. Dep.

The program is outlined for fuel irradiation experiments in the Fermi Fast Breeder Reactor. The design of the fuel pins and performance data are given. Na coolant temperatures for stainless steel-clad and Inconel 625-clad pins at nominal power and at 130% of power are calculated and the results tabulated. Fuel temperature at nominal and 130% of power of the Inconel 625-clad pins are tabulated. The criteria a fuel test assembly must meet for nuclear safety are discussed. (J.C.W.)

42728 (KFK-595) SOME CONSIDERATIONS ON GAS COOLING FOR FAST BREEDERS. Dalle Donne, M.; Eisemann, E.; Wirtz, K. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). May 1967. 15p. Dep.

Extrapolations of a high-temperature, He-cooled, thermal power reactor to a high-temperature, He-cooled, fast breeder power reactor of 21 MW(e) output is discussed. Problems of materials research, especially for fuel element cladding, are considered. Comparisons are made between steam cooling and He-cooling. A steam-cooled reactor appears to require less component development work than the He-cooled, because of turbine problems. Capital, operating, and breeding economics are studied. (J.M.J.)

42729 (LA-3745) ADVANCED PLUTONIUM FUELS PROGRAM. Quarterly Status Report, April 1-June 30, 1967. (Los Alamos Scientific Lab., N. Mex.). Aug. 30, 1967. Contract W-7405-eng-36. 93p. Dep. CFSTI.

The experimental program is concerned with the effects of long-time contact between trace-irradiated, Pu-containing fuels and 500° to 700°C Na. A high-purity ternary alloy of Pu, Co, and Ce with a melting point near 435°C is used as a source of fission products for the transport and distribution in the Na loop experiment. The ranges of contamination levels found in Na and on stainless steel specimens for ^{90}Sr, ^{106}Ru, ^{125}Sb, ^{137}Cs, ^{144}Ce, ^{155}Eu, and ^{239}Pu are summarized. Sodium-coolant chemistry associated with the control of chemical reactions occurring in the Na coolant is investigated for the LMFBR program. The solubility of O_2 in Na using the vacuum-distillation analytical technique has been evaluated over the temperature range of 125° to 300°C. The Analytical Loop No. 1 has been modified and Analytical Loop No. 2 is being completed. The Na system for the cold trap characterization tests has been completed. Experiments determined the effect of cooling rate of a plugging orifice on the indicated plugging temperature. Phase equilibria and general properties, specific thermodynamic properties, free energy of formation in the 450 to 1200°C temperature range, and heat capacity and heat of transition are properties being investigated for Pu fuel materials. The interactions among single-phase mixed U-PuC, a Na bond and potential cladding materials are studied and a literature survey completed. Four isothermal Na loops have been completed. Testing was carried out and the O_2 analyses of Na tabulated. A study of nitride fuel is being conducted. An apparatus was constructed for measuring the pressure developed by a nitride material or fuel pellet on heating to 900°C. A system for loading ceramic fuel pellets and Na into test capsules is complete and testing is in progress. Work on numerical methods for the treatment of neutron and γ-ray transport problems has included improvements in codes for input-output data preparation, completion of a code in which the method of continuous analytic continuation is applied to reactor kinetic problems, a comparison of experimental and calculated data for fission product decay in ^{239}Pu fast fission for application to heat deposition in fast reactor shields, the preparation of a transport theory burnup program, and studies of computer programs for multimode reactor kinetics and space-time-dependent multigroup neutron transport. Work has proceeded on the measurement of gaseous diffusion rates in metals, the correlation of nondestructive tests with liquid metal coolant leaks, and γ-ray scanning techniques. (J.C.W.)

42730 (NAA-SR-12408) NONNUCLEAR PERFORMANCE OF SRE-PEP SYSTEMS. Gunby, A. L. (Atomics International, Canoga Park, Calif.). June 30, 1967. Contract AT(04-3)-701. 59p. Dep. CFSTI.

The modifications for the SRE facility for higher temperature and power and greater reliability are given. Performance testing of the modifications is discussed. Gas entrainment for the SRE-PEP Na primary pumps is discussed. The capability of retrieving metallurgical sample tabs from radioactive primary sodium without interrupting reactor operation was checked out. Instrumentation check-out revealed unstable amplifiers in the heat transfer portion and inadequate diodes in the reactor safety system. Corrections to these instrumentation deficiencies are outlined. (M.L.S.)

42731 (ORNL-TM-1899) DISTRIBUTION OF FISSION PRODUCTS FOLLOWING A NUCLEAR INCIDENT. Cottrell, Wm. B. (Oak Ridge National Lab., Tenn.). June 21, 1967. Contract W-7405-eng-26. 39p. (CONF-660907-12). Dep. CFSTI.

From American Chemical Society Meeting, New York.

The data on fission product release from actual reactor incidents and simulated accidents was reviewed. From the former it was evident that the measured releases, generally noble gas, were but a fraction of that for which the systems had been designed and that the consequent radiation injuries even to "radiation workers" constitute a very small fraction of their total injuries. The extensive research and development sponsored by the AEC on fission product behavior under simulated accident conditions has resulted in an understanding of the release mechanism as a function of many accident parameters. Furthermore, since consequence-limiting safety features are more demonstrable and acceptable than accident-limiting safeguards, the thrust of the R & D program is toward the transport and removal of released fission products and the verification of this behavior in large scale experiments. (auth)

42732 (UNC-5170) IRRADIATION OF HIGH DENSITY (UPu)C IN EBR-II. DESIGN AND FABRICATION REPORT OF RODS 81 THROUGH 90. Andersen, J.; Cherry, B.; Cihi, J.; Powers, R.; Stahl, D. (United Nuclear Corp., Elmsford, N. Y. Research and Engineering Center). Mar. 24, 1967. Contract AT(30-1)-3415. 121p. Dep. CFSTI.

Ten rods fueled with high density (UPu)C pellets were designed, fabricated, encapsulated for irradiation at 655 and 985 W/cm, to 14, 17.5, and 35×10^{20} fiss/cm^3 burnup in the EBR-II. The cladding materials are Incoloy-800 and type 316 stainless steel. The objective of the tests is to determine the proper He-fuel-clad gap size which would accommodate fuel swelling while preventing excessive clad strain and fuel temperature. The compatibility of various materials with (UPu)C was verified by testing at 800°C. No reactions were found after 1000 and 4000 hr with Incoloy-800, type 316 stainless steel, or with Inconel-625. A reaction was found with V-20 wt % Ti alloy after 4000 hr but none was found after 1000 hr. The solid, high density pellets of $(U_{0.80}Pu_{0.20})C$ plus 0.1 wt % Ni were fabricated by the carbothermic reduction of oxides, followed by cold pressing and sintering. The rods were encapsulated into type 304 stainless steel capsules with a Na bond. The capsules were nondestructively tested, including an eddy current test for bond integrity. (J.R.D.)

42733 FUEL CYCLES OF GAS-COOLED HIGH-TEMPERATURE-REACTORS. Klusmann, A.; Voelcker, H. Atomkernenergie, 12: 289-97(1967). (In Germany).

Based on its excellent fuel utilization and its low power generating cost, the High-Temperature-Reactor is one of the advanced converters with good future prospects. The present situation of this reactor type is described. The given physics data of the different fuel cycles demonstrate the flexibility of the reactor concerning the selection of nuclear fuels. The characteristics of the ceramic fuel elements and the material problems in high temperature operation are discussed. The essential results of the first power run of the 20 MW(t)-Dragon-Reactor are summarized. Costing of HTR power plant projects is given briefly. (auth)

42734 THE DEVELOPMENT OF NUCLEAR POWER PLANTS FROM THE VIEWPOINT OF ENERGY ECONOMICS. Michaelis, Hans. EURATOM Bull., 6: 40-4(June 1967).

The European nuclear power facilities are reviewed. Existing plants are discussed concerning operation economics, and proposed plants are presented. Reactor types described include: light-water reactors, graphite-gas reactors, AGR reactor, heavy-water reactors, and high-temperature gas reactors. A discussion on the economic competitiveness of nuclear power plants in Europe is also presented. (D.C.C.)

42735 NUMERICAL ANALYSIS OF THE SOLUTIONS OF TELEGRAPHIST'S EQUATION FOR TWO TYPES OF TIME-DEPENDENT NEUTRON SOURCE. Pasquantonio, F. (ENEL, Milan); Motta, M. Energia Nucl. (Milan), 14: 453-64(Aug. 1967).

The numerical analysis of the P_1 approximation of the one velocity transport equation is given in the cases of step source and sinusoidal source. The PRONEWA and CONV codes have been developed for this purpose. The former allows the calculation of solutions of the semi-infinite medium, while the latter is concerned with those relating to the slab. The CONV code, a routine for the evaluation of convolution product of two functions assigned in a finite sequence of distinct points, is presented. This code can be used in the calculation of convolutions which cannot be solved analytically in closed form. (auth)

42736 SIMPLE MODEL FOR CALCULATION OF THE MACROSCOPIC POWER DISTRIBUTION IN A LIGHT WATER REACTOR. Locke, G. (Univ., Kiel). Atomkernenergie, 12: 233-9 (1967). (In German).

The conditions which allow a reduction of the number of fast neutron energy groups needed for a calculation of the macroscopic flux distribution in a light water reactor are considered. A model with one fast neutron energy group is a good approximation. For light water reactors the remaining two group model can be reduced to a one group model describing the fast neutron flux. The thermal neutron flux can be derived from the fast flux by algebraic operations ($1\frac{1}{2}$ group model). For core regions in the neighborhood of the reflector a correction of the $1\frac{1}{2}$ group model is given. The neutron fluxes in a light water reactor core are calculated by the $1\frac{1}{2}$ group model and by a three group diffusion theory. The agreement between the results obtained from this model and the results of three group calculations is good. (auth)

42737 DETERMINATION OF THE RADIATION FIELD IN NUCLEAR REACTOR SHIELDS FROM MEASUREMENTS AT A LIMITED MONODIRECTIONAL BEAM. Thuro, G.; Pazelt, H. (Institut fuer Reaktorphysik, Geesthacht, Ger.). Atomkernenergie, 12: 267-78(1967). (In German).

A method to measure the intensity distributions of neutrons and γ-rays in the shield of a nuclear reactor or of another radiation source is found from measurements at a limited monodirectional beam of a nuclear reactor beam-hole. The measurements yield the corresponding radiation field due to a plane monodirectional beam. The intensity distributions in the shield are found with the help of the appropriate geometric attenuation function. The comparison of the results of 6 different shield compositions confirms the usefulness of this method within an error of about 35%. (auth)

42738 OPTIMIZATION OF SOLID BURNABLE POISONS. Buenemann, D. (Institut fuer Reaktorphysik, Gesellschaft, Ger.). Atomkernenergie, 12: 285-6(1967). (In German).

The following elementary considerations lead to an optimization of solid burnable poisons. All quantities are related to the mean thermal neutron flux in the active core by means of reaction rates and self shielding factors. Spectral coupling of poison and fuel is neglected in a first approximation but can be taken into account in a second calculation. The space dependent weighting of the poison by the importance is included in the self shielding factor. (auth)

42739 NUCLEAR POWER DEVELOPMENT IN INDIA. Ramamoorty, M. (Indian Inst. of Tech., Madras). Indian J. Power River Valley Develop., 14: 1-4(Apr. 1964).

Future electric power estimates for India indicate that over 13 million kW of installed capacity by 1966 is expected to be made up of about $5\frac{1}{4}$ million kW of hydro and $7\frac{1}{2}$ million kW of thermal and about 190 MW of nuclear power. The latter will be from the proposed Tarapur station to be situated on the West Coast region about 60 mi north of Bombay. The Tarapur station will have a capacity of 380,000 kW and will consist of 2 boiling water reactors, each supplying steam to a turbogenerator of 190,000 kW capacity. The first stage of the station is to be completed by 1966. The total outlay on the station is estimated to be Rs. 48.4 crores. The cost of power from the Tarapur station is estimated to be 3.22 nP/kWh. The cost estimate is based on conservative assumptions and should drop to 3 nP/kWh as a result of lower costs of reprocessing and fabrication of fuel when these functions are performed in India. The life of the station is assumed to be 20 yr. The cost of power from a modern coal-fired station located in this region would be about 3.76 np/kWh due to the high transport charges of coal. Thus power from the Tarapur station will be cheaper than that from an alternative coal-fired station. The Government of India has also decided to install a 200-MW atomic power station at Ranapratap Sagar, near Kotah in Rajasthan, at an estimated cost of Rs. 32 crores. This station is expected to be completed by early 1968 and will help to meet the power requirements during the fourth Plan period. The station will use natural uranium oxide as fuel and heavy water as moderator and coolant. The cost of generation of nuclear power at Ranapratap Sagar will be about 3 nP/Kw-hr as against the cost of generation of 3.7 nP/Kw-hr from a conventional thermal station in that locality. The Indian Atomic Energy Commission has suggested the duplication during the fourth Plan of the Ranapratap Sagar station by the addition of a second unit of 200 MW. A further 400 MW nuclear capacity for the west coast region is being proposed for completion towards the end of the fourth Plan period. Based on information supplied by the various industrial consortia, the fixed capital cost of a nuclear power station in general is about Rs. 1700/kW in India. (BBB)

42740 SOME FACTORS IN SELECTING MATERIALS FOR NUCLEAR REACTORS. Smith, Charles O. (Univ. of Detroit). Nav. Eng. J., 79: 233-7(Apr. 1967).

General considerations for selection of materials are reviewed with emphasis on mechanical strength, ductility, stability, fabricability, availability, corrosion resistance, heat transfer properties, special properties, and cost. Some additional factors in selection of reactor materials also considered are: neutron-absorbing characteristics, susceptibility to induced radioactivity, radiation damage resistance, and ease of chemical processing. It is necessary to first estimate the specific problems in a given design and then select the proper materials (with possible alternates) for the specific service, i.e., operating conditions. No set of selection rules is completely applicable under any and all circumstances. The final selection of materials will represent the best compromise obtainable. For example, it may be necessary to select a less corrosion-resistant cladding which can be more easily processed for fuel recovery or a more corrosion-resistant cladding with a more difficult recovery problem. It is essential to know and understand the conditions of fabrication and service, including temperature, specific environment, operating stress level, and other factors, for selecting the proper material. In selecting materials it is important to determine whether strength is adequate to withstand the stresses imposed by service loading. While the primary selection criterion is often strength, it may also be toughness, corrosion resistance, electrical conductivity, magnetic characteristics, thermal conductivity, sp gr, strength-weight ratio, or other properties. (BBB)

42741 NUCLEAR FUEL ELEMENT CONCEPTS. Smith, Charles O. (Univ. of Detroit). Nav. Eng. J., 79: 59-68(Feb. 1967).

The following aspects of fuel element design and fabrication are reviewed: nuclear and thermal phenomena, types of fuel elements, bonded metallic elements, dispersion type elements, MTR (Materials Testing Reactor) types, container type elements, radiation effects on fuel and cladding, and fuel reprocessing. A major objective in fuel element design is an optimum combination of specific power and operating life. It is explained how life is determined by operating temperature, heat flow, corrosion, interaction of fuel and cladding, interaction of cladding and coolant, permissible burnup of fissile atoms, and/or build up of fission product poisons. A large number of fuel elements with a great variety of combinations of fuel, cladding, and geometry have been used, designed, or proposed. The following technological factors in selecting materials for solid fuel elements are considered: general design specification, nuclear characteristics, physical and mechanical properties, thermal properties, chemical compatibility and reprocessing, service performance and handling, fabrication and testing, and material and processing costs. Factors in selecting cladding material for fuel elements which are discussed include: neutron absorption, induced radioactivity, mechanical strength, ductility, stability, availability, fabricability, melting point, thermal conductivity, coefficient of thermal expansion, modulus of elasticity, ignition temperature, vapor pressure, compatibility (with fuel and with coolant), resistance to aqueous corrosion, and ease of chemical processing. A detailed description is given of some elements which are used in specific reactors in the United States and United Kingdom. (BBB)

42742 NUCLEAR ENGINEERING DEVELOPMENT IN THE EEC AREA UP TO THE YEAR 2000. Schmidt, Gerhard (Berliner Kraft- und Licht-(Bewag)Aktiegesellschaft, Berlin). Elektrotech. Z., 19: 33-6(Jan. 27, 1967). (In German).

The inauguration of the nuclear power station at Gundremmingen affords an occasion for the prediction of the future position of primary energy in the European Economic Community. For power generation, fossil fuels will steadily be replaced by nuclear energy. In the case of large block units, nuclear energy has already achieved the economic efficiency of coal and oil for power generation. In the seventies operation of power stations with breeding reactors is anticipated to modify forecasts for power generation and nuclear fuel supplies. By 2000 installed total power in nuclear power plants will exceed 300 GW(e); tested reactors will produce 70 GW(e); heavy water reactors, 110 GW(e); and breeding reactors, 180 GW(e). Yearly requirements of U will be approximately 15×10^3 tons of natural U and 3×10^3 tons of enriched U in the EEC (European Economic Community) area. (BBB)

42743 LIQUID FUELS IN NUCLEAR REACTORS. Smith, Charles O. (Univ. of Detroit). Nav. Eng. J., 78: 977-84(Dec. 1966).

Use of aqueous, liquid metal, and molten salt fuels in nuclear reactors is reviewed. Temperature limitations and radiation effects with aqueous fuels are considered. Reactors with aqueous fuel are restricted to relatively low temperature operation by pressure limitations or phase stability of fuel. Use of liquid fuels eliminates radiation changes in dimensions and physical properties which drastically limit solid fuels, but induced chemical changes must be considered in reactor design and operation. Details are given of the homogeneous reactor experiment of the Oak Ridge National Lab, the Liquid Metal Fuel Reactor proposed by Brookhaven National Lab, and the Los Alamos Molten Plutonium Reactor

Experiment. Molten salts and liquid metals have the attractive features of potential high thermal efficiency with low pressure operation at high temperature and minimum susceptibility to radiation damage. The Aircraft Reactor Experiment, providing for a circulating-fuel, high-temperature reactor designed for 1.5 Mw, is explained and diagrammed, as is the Molten Salt Reactor Experiment. The relative merits of various liquid fuels are discussed. (BBB)

42744 MODIFICATIONS TO THE D.F.R. BREEDER. Phillips, J. L. (United Kingdom Atomic Energy Authority, Dounreay, Scotland). Reactor, 6: 3-7(1967).

As a result of excessive fuel swelling in the outer breeder elements, over 500 were so distorted as to be incapable of removal by the normal refueling machine. A description is given of the engineering work involved which included the design and use of a number of cutting and handling tools and, on lowering the coolant level, the installation of a coolant tank and 125 kW vault heating. Effects of the modifications on future operation were studied and predictions were confirmed on resumption of full power. Radiation and contamination conditions during the work are reported. (UK)

42745 EXPERIMENTAL PROGRAMMES IN THE WINDSCALE A.G.R. Gallie, R. R. (United Kingdom Atomic Energy Authority, Windscale, Eng.). Reactor, 6: 14-20(1967).

The reactor has been used to carry out development programs on fuel and graphite, and for some reactor physics work, while obtaining an overall load factor of 76%. Fuel of 0.4 in. dia (Mk.II) and 0.57 in. dia (Mk.III) has been irradiated in the 100 experimental channels to peak irradiations of 20,600 and 14,500 MWd/te, respectively. Studies of the coolant/graphite reaction in the reactor led to a coolant composition including small amounts of CH_4 and CO. The physics program has consisted of a comparison of theoretical predictions and experimental results for a number of reactor parameters. (UK)

42746 THE FUTURE OF NUCLEAR POWER AS SEEN FROM BRITAIN. Penney, William (United Kingdom Atomic Energy Authority, London). S. Afr. Mining Eng. J., 633-4; 636; 638 (Mar. 17, 1967).

Economic and technical aspects of nuclear power development in the United Kingdom are discussed. The United Kingdom has a relatively high fuel cost economy and therefore provides a great opportunity for nuclear power to capture a good share of the electricity generating capacity ordered in the future. When there has been competition between coal, oil, and nuclear power in the bidding for a particular station, a realistic and reliable comparison can be made. Several cases where the facts of such a competition have been published are discussed. One comparison was between nuclear bids for a twin reactor station 2×600 Mw(e) at Dungeness and a 2000 Mw(e) coal-fired station being built at Cottam, close to one of the best coal fields in Nottinghamshire. The generating costs from the nuclear station were 13% lower than those from the larger coal-fired station, built on the coal field, but the unit capital cost of the nuclear station was appreciably higher. The Central Electricity Generating Board estimated that the unit costs of a later nuclear station 2×1000 Mw(e) can be improved by 20%. The evidence that nuclear power can compete successfully with other methods of generating electricity is thus accumulating. Assessments of the economics of fast reactors indicate that they will be able to compete favorably with the present types of stations, projected 10 yr ahead. The fast breeder reactor, however, is very economical in its use of natural U and the more the price of natural U increases, the more favorable becomes the economics of fast reactors, compared with other reactors. There is also the possibility of exploiting the high temperature converter reactor developed from the Dragon reactor experiment in which 12 European countries have collaborated. This system would also be economical in its use of natural U as compared with other thermal reactors, though it is not as good as the fast reactor. Like the fast reactor, the Dragon high temperature system can use Th in some of the possible fuel cycles. Performance data of U. K. power reactors, some of which have been in operation for 10 yr, are outlined, and possibilities presented by the breeder reactor program are speculated upon. (BBB)

42747 INTEGRATED STEAM-GENERATORS IN PRESSURIZED-WATER REACTORS. Dien, R. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Geesthacht, Ger.). Kerntechnik, 9: 354-60(Aug. 1967). (In German).

The principles of once-through steam generators and a corresponding computer program are described. The main parameters calculated for different cases of layout are plotted in a diagram showing the character of this kind of steam generators. The mass velocity of the secondary medium is an important factor for the performance of once-through boilers. It is to be seen that this value cannot exceed an upper limit caused by the pressure drop in the tubes, if full evaporation is required. The diagram based on parameters that can be varied by formulas explains the dependence of heat-transfer area on pressure drop and points out the difference to other steam generators normally used in stationary reactor power plants. High efficiency of the secondary circuit requires high pressure in a turbine plant of great power working with saturated-steam conditions. Realizing this high secondary pressure, certain layout limits for the design of once-through steam boilers are obtained. (auth)

42748 THE Pu-ENRICHED U ALTERNATIVE FOR THE DEVELOPMENT OF A FAST REACTOR SERIES. Banal, Michel; Zaleski, Pierre (Commissariat a l'Energie Atomique). Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.), No. 65, 37-46(1967). (In French).

The use of enriched U rather than Pu in fast reactors is examined. The technical characteristics of fast reactors using ^{235}U or Pu as fuel are compared. The value of demonstrating a fast reactor prototype using ^{235}U is discussed. The economics of the use of ^{235}U are compared with the use of Pu. The long term program for the development of fast reactors and thermal reactors is considered with respect to the availability of Pu and the French economy. It is concluded that enriched U reactors would be economically feasible if the price of Pu exceeds 15 to 20 $/g. (J.S.R.)

42749 PROGRAM AND ECONOMY OF FAST REACTORS. REPORT PREPARED FOR SESSION VI OF THE THIRD FORATOM CONGRESS. Gibrat, Robert ; Gaussens, Jacques; Lichtenberger, Francis (Commissariat a l'Energie Atomique). Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.), No. 65, 19-36(1967). (In French).

An economic evaluation is made of fast reactors. The investment cost, fuel cost, annual operating cost, and probable future costs of fast neutron reactors are evaluated. The rate of introduction of fast reactors into the French economy is estimated on the basis of the quantative model and the model for the determination of the Pu cost. The French program is examined and predictions are made on the installed capacity in different reactor types up to the year 2000. (J.S.R.)

42750 THE PHENIX PROTOTYPE REACTOR. REPORT PREPARED FOR SESSION IV OF THE THIRD FORATOM CONGRESS. Vautrey, Louis; Faure, Jacques (Commissariat a l'Energie Atomique). Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.), No. 65, 5-18(1967). (In French).

Design studies made on the PHENIX, a Na cooled power reactor, are reported. Design studies were made for two power levels of 125 and 250 MW(e). The factors governing the selection of the parameters for the core and thermal characteristics are discussed. The principal components of the reactor are described in detail. It is planned that the construction of this reactor will begin in 1969. (J.S.R.)

42751 BOUNDARY PERTURBATIONS IN MULTIGROUP DIFFUSION THEORY. Spinks, N. (Atomic Energy Commission, Lucas Heights, Australia). Nucl. Sci. Eng., 29: 458-62(Sept. 1967).

The calculation of the reactivity worth of an array of fully or partially inserted control rods is often made by solving the multidimensional multigroup diffusion equations in the reactor volume. For a solution by numerical methods the reactor volume is divided into a number of small homogeneous regions by mesh surfaces, which in the case of polar geometry, are surfaces of constant radius and surfaces of constant azimuth. All internal surfaces between regions of differing properties, and all internal boundary surfaces, must correspond with the mesh surfaces. A variational principle for the reactor multiplication constant, which allows perturbations of boundary surfaces, is useful for determining the reactivity worth of control rods that cannot be represented by the mesh surfaces allowed in the numerical methods of calculation. This method of solution is presented. (D.C.C.)

42752 EFFECTIVE RESONANCE INTEGRAL OF 30-mil THORIUM WIRE RELATIVE TO THE INTEGRAL AT INFINITE DILUTION. Rothman, A. B.; Connor, J. C.; Conway, D. E. (Westinghouse Electric Corp., West Mifflin, Pa.). Nucl. Sci. Eng., 29: 462-4(Sept. 1967).

The effective neutron-capture resonance integral of 30-mil-dia Th wire is measured relative to the integral at infinite dilution by comparing the Cd ratio measured for the wire with the Cd ratio measured by Hardy, in the same spectrum, for dilute-Th foils. The Th wire is used for ^{233}Pa resonance integral experiments. The measurement was made because the self-shielding of the wire is in an intermediate region not previously investigated (surface-to-mass value of 4.65 cm^2/g). (auth)

42753 THE METHOD OF SOLUTION-FUNCTIONS: A COMPUTER-ORIENTED SOLUTION OF BOUNDARY VALUE PROBLEMS AS APPLIED TO NUCLEAR REACTORS. PART 1. CYLINDRICAL

REACTORS IN ρ-θ GEOMETRY. Bobone, Renato (Knolls Atomic Power Lab., Schenectady, N. Y.). Nucl. Sci. Eng., 29: 337-53 (Sept. 1967).

The solution of a multidimensional, many-region boundary value problem is expressed, in each region, by a truncated, rapidly convergent series of functions that are solutions of the partial differential equation in the given region, i.e., "solution-functions." The eigenvalues and the corresponding eigenfunctions of the problem are then found by a least mean square method. This scheme is applied by means of a computer to the calculation of eigenvalues and eigenfluxes in the diffusion approximation of a nuclear reactor of cylindrical geometry. (auth)

42754 ANALYSIS OF PULSED-NEUTRON EXPERIMENTS IN MODERATORS VIA A SIMPLE MODEL. Corngold, Noel (Brookhaven National Lab., Upton, N. Y. California Inst. of Tech., Pasadena); Durgun, Kanat. Nucl. Sci. Eng., 29: 354-66 (Sept. 1967).

The decay of a neutron pulse in small nonmultiplying systems, through the use of a simple model for the moderator, is presented. The model, a modified one-term degenerate kernel, enables us to include crystal-effects and to reduce Boltzmann's equation to quadratures. The structure of the continuum contribution, and the analytic continuation of the functions λ_k (B^2) are discussed. Some of the puzzling aspects of pulsed-neutron experiments in crystalline moderators, and the multigroup calculations which accompany them are clarified. (auth)

42755 PROMPT-NEUTRON KINETICS OF A SPHERICAL-CAVITY REACTOR. Podney, Walter N.; Smith, Harold P. Jr. (Univ. of California, Berkeley). Nucl. Sci. Eng., 29: 373-80 (Sept. 1967).

A simple kinetics model is proposed that describes time dependence of the prompt-neutron population in a cavity reactor in terms of a linear, first-order differential equation for the net thermal-neutron current at the cavity wall. The model is applicable if the cavity albedo changes slowly during a neutron lifetime and does not exceed a specified maximum value. This range of applicability is defined by deriving the kinetics equation on the basis of an age-diffusion theory approximation that describes the time dependence of the thermal-neutron flux at the cavity wall in terms of a Volterra integral equation of the second kind. The method of deriving the kinetics equation suggests a means of experimentally determining the effective multiplication factor and average neutron lifetime-to-fission for more complex cavity geometries by measuring thermal-neutron absorption rate in a nonmultiplying gas in the cavity. (auth)

42756 SOLUTION OF THE SPACE–TIME NEUTRON GROUP DIFFUSION EQUATIONS BY A TIME-DISCONTINUOUS SYNTHESIS METHOD. Yasinsky, J. B. (Westinghouse Electric Corp., West Mifflin, Pa.). Nucl. Sci. Eng., 29: 381-91(Sept. 1967).

A variational principle, which has as its stationary conditions the direct and adjoint time-dependent group diffusion equations, is modified to admit time-discontinuous approximating functions. This extended principle is used to develop a synthesis approximation for the time-dependent group diffusion equations which permits the use of different sets of trial functions at different times during a transient analysis. The necessary equations are derived in detail, and two numerical examples are presented. These examples show that the time-discontinuous synthesis method is capable of constructing accurate space-time neutron fluxes, which vary smoothly in time, from spatial trail functions which are discontinuous in time. In addition, these examples display the potential of the new time synthesis for yielding computationally less expensive solutions than are possible with the time-continuous synthesis procedure. (auth)

42757 SOLUTION OF THE REACTOR KINETICS EQUATIONS BY ANALYTIC CONTINUATION. Vigil, John C. (Los Alamos Scientific Lab., N. Mex.). Nucl. Sci. Eng., 29: 392-401(Sept. 1967).

A method based on analytic continuation, which is well suited for fast digital computer application, has been applied to the point reactor kinetics equations. The most important characteristic of the method is that it yields an analytic criterion for the magnitude of the time step. This criterion is such that the time step automatically expands or contracts, depending on the behavior of the function within each interval. The use of this criterion to determine the time step guarantees that the fractional error in the results increases, at most, linearly with the number of time steps. Furthermore, the magnitude of the time step determined from this criterion can be much larger than the prompt-neutron generation time. Approximate solutions by this method were compared with some analytic solutions to the reactor kinetics equations, and the error accumulation was found, in all cases, to be within the limits predicted by the theory. Comparisons were also made with experimental transients in the Godiva and SPERT I reactors. The approximate results were found to agree well with experiment in the range of reactivity inputs where the feedback model used is valid. In a comparison with another numerical method (RTS code), analytic continuation was found to be 25 times faster. 8 references. (auth)

42758 3RD FORATOM CONGRESS: INDUSTRIAL ASPECTS OF A FAST BREEDER REACTOR PROGRAM. Lombardi, C. (CISE, Milan). Energ. Nucl. (Milan), 14: 475-86(Aug. 1967). (In Italian).

A review of the 3rd Foratom Congress on "Industrial Aspects of a Fast Breeder Reactor Program." The primary topics discussed are: fast reactor development objectives in Europe, fuel fabrication and reprocessing, experimental prototype designs, Th–^{233}U reactors, and fast reactor economics. (M.L.S.)

42759 RESEARCH ON THE SAFETY OF NUCLEAR POWER REACTORS. Morrison, David L. Battelle Tech. Rev., 16: 3-9(Sept. 1967).

Research in areas relative to nuclear power reactor safety has provided considerable insight into the problems that may be encountered in the unlikely event of a major accident. Within current understanding of the problems, effective means for counteracting the accident have been devised, and approaches that should lead to a reduction in the probability of occurrence of the accident are being followed. However, in view of the potential consequences, additional understanding of the possible accident is being sought through continuing research efforts. Confidence in the ability of nuclear science and industry to design and protect against the consequences of the accident or to prevent it is directly proportional to the understanding of all facets of the problem. (auth)

42760 ADSORPTION OF IODINE BY ATMOSPHERIC PARTICLES. Garland, J. A. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Energy, 21: 687-700(Sept. 1967).

Laboratory-scale experiments show that an appreciable proportion of airborne I_2 becomes attached to particles naturally present in the atmosphere. The rate of attachment is slow, the values of the accommodation coefficient lying in the range 2×10^{-3} to 10^{-2}. Autoradiographic experiments and consideration of the mass adsorbed suggest that most of the particles present adsorb I_2. Iodine desorbs slowly from particles, so that an equilibrium is set up with a considerable proportion of the I_2 present as vapor. This fact may be important in determining the long-term travel and deposition of I_2 released to the atmosphere. Most of the adsorbed I_2 is found on submicron particles, but the proportion of the adsorbed activity found in larger size ranges is somewhat greater in the case of I_2 than for thoron daughters. (auth)

42761 STUDIES ON THE COATING OF FUEL PARTICLES FOR THE 'DRAGON' REACTOR EXPERIMENT. Gough, J. R. C.; Kern, D. (Atomic Energy Establishment, Winfrith, Eng.). J. Nucl. Energy, 21: 623-42(Aug. 1967).

The requirements of fission product retaining coatings on coated fuel particles are reviewed and the scope of development necessary to meet these requirements for the initial charges of the DRAGON Reactor Experiment is described. These studies on the coating of fuel particles were carried out using a laboratory scale fluidized bed type of coating furnace. Within the range of deposition temperatures investigated, laminar or metallographically structureless pyrolytic C was deposited with methane concentrations greater than 15 per cent, while the structure deposited at low methane concentrations was columnar. Appreciable temperature gradients were found in these small fluidized beds of fuel particles, particularly under the relatively static conditions of fluidization which favored deposition of the columnar structure. The rate of deposition of pyrolytic carbon was found to increase linearly with methane concentration at a given temperature, and within specified limits of methane concentration such that the relationship was linear within each of two separate ranges of concentration corresponding to the different metallographic structures. The room temperature density of the deposited pyrocarbons showed minimum values for deposition temperatures of 1600 to 1700°C. Under the experimental conditions described, the carbon efficiency of deposition increased to the order of 100 per cent at deposition temperatures of 1600°C and above. The deposition of SiC interlayers from methyltrichlorosilane is also described. The surface contamination of coated particle fuel was shown to be sensitive to the temperature of deposition of the pyrocarbon, to the rate of deposition at a fixed temperature, and to the presence of SiC interlayers. The latter reduced surface contamination to near background values. (auth)

42762 ANALYTICAL APPROACH TO THE TIME DECAY CONSTANTS OF A NEUTRON PULSE IN SLABS AND SPHERES OF ARBITRARY THICKNESS. Hembd, H. (EURATOM, Ispra, Italy). Atomkernenergie, 12: 334-6(1967). (In German).

A new method to solve the Boltzmann equation is developed and

applied to the determination of the time decay constant of a neutron pulse. The method is based on the integral form of the Boltzmann equation which has the property to exactly satisfy the boundary conditions for samples of arbitrary thickness. The essential step is a Fourier-transformation of the integral equation and the replacement of the new kernel by a well-known expansion into spherical Bessel functions. The linear algebraic system of equations derived in this way is the same as it has been established previously by Asaoka in his j_n-method. The eigenvalues of this system correspond to the decay constants. For thin samples up to several mean free paths two terms in the expansion are sufficient to determine the fundamental decay constant within an error of 1% or less. (auth)

42763 SOME REMARKS ON H_2O FOG COOLED REACTORS MODERATED WITH COLD HEAVY WATER AND FUELLED WITH NATURAL URANIUM. Silvestri, M. (CISE, Milan). Energ. Nucl. (Milan), 14: 509-18(Sept. 1967).

A heavy water moderated, cooled by light water in change of phase, natural U fueled reactor concept, called CIRENE, is being developed in Italy. The economics of this concept are summarized. The more general aspect of the economic competition between advanced converters and fast breeder reactors is examined. Through an evaluation of the long range fuel cost trends which take into account scale factors, the conclusion is drawn that a too rapid development of fast breeder reactors could waste money and endanger their very position in the frame of the nuclear evolution of the civilized world. (auth)

42764 AN ANALYSIS OF THE "LAMINAR INSTABILITY" PROBLEM IN GAS-COOLED NUCLEAR REACTOR PASSAGES. Reshotko, Eli (Case Inst., of Tech., Cleveland). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 5: 1606-15(Sept. 1967).

Nuclear reactor passages in laminar flow have long been regarded as unstable in that region of operation where the rate of change of pressure drop with weight flow at constant heat input is negative. A time-dependent stability analysis of the problem affirms that this criterion is valid for excursions at constant pressure drop and shows that the instability is associated with the thermal response of the reactor core to an infinitesimal disturbance. The analysis also allows the calculation of a complete excursion at constant pressure drop from an initially unstable laminar equilibrium point. An excursion toward higher flow rate will continue until the high flow rate for the same pressure drop and heat rate to the gas is realized, probably under conditions of turbulent flow. An excursion to lower flow rate will progress until there is tube burnout. With increase in the heat capacity of the reactor core, the time for a complete excursion increases. The turbulent flow equilibrium points are always stable to excursions at constant pressure drop. Stability criteria are also presented for excursions at other than constant pressure drop. The method of analysis is such that growth rates may be obtained for any reactor whose steady-state conditions are known whether they be for uniform heating, cosine heating, or any form of zoned heating. (auth)

42765 MARVIKEN: SWEDEN'S SECOND POWER REACTOR IN CONSTRUCTION. Karker, S. (Aktiebolaget Atomenergi, Studsvik, Sweden). Ing. Bygningsv., 62: 154-8(Aug. 7, 1967). (In Swedish).

The design of the Marviken power station with a heavy water reactor is reviewed. The reactor tank with internals, the control rod system, the fuel elements, the on-power refuelling system, the main circulating system, the turbine, the building lay-out, and the PS containment system are described. A review of the main data and the history of the station is included. (auth)

42766 NUCLEAR REACTORS WITH HELIUM TURBINES FOR HIGH POWERS. Bammert, K.; Twardziok, W. (Technische Hochschule, Hanover). Atomkernenergie, 12: 305-26(1967). (In German).

The development of the gas-cooled high-temperature reactor, whose prototypes are in successful operation, enables the temperatures of the coolant to be considerably increased as compared with those applied in water-cooled reactors. The direct connection between the gas turbine and the high-temperature reactor allows full utilization of this high temperature and very economical generation of electrical power. As the coolant He is inert and not subject to activation, there is no obstacle to the direct connection of a turbine single-cycle system. As a result of the ever increasing power demand there has been a marked tendency towards adopting high unit capacities. The He turbine has proved that it is suitable for very high capacities and also offers special advantages particularly in the higher capacity range. The fundamentals of thermodynamics, especially the characteristics of the cycle processes and the influence of the working medium on the efficiency and unit size and the layouts of He turbines of high capacity (300, 600, 1000 MWe) are summarized. The optimization of the cycle processes and the choice of the most suitable designs of the machines and heat exchangers are described. By comparing the sizes of He turbines with those of open- and closed-cycle turbines handling other gases it is shown that the dimensions of the He turbines of high capacity are comparable to those of other gas turbines already built and in operation. Therefore in solving design and manufacturing problems it is possible to make full use of the practical experience gathered in building and operating ordinary gas turbines. Finally the He turbine is compared with the conventional steam turbine as used—in a two-cycle system—with high-temperature reactors. While the leading position of the high-capacity steam turbine in the classic technique of power conversion is undisputed, the He turbine enters the foreground with nuclear power plants comprising a high-temperature reactor. The size and power/weight ratio which are important factors of the plant cost are below that of nuclear-fired steam turbines. The difference increases with rising unit capacity. The small space requirements, the exclusion of the steam generator and the favorable efficiencies of the He units lead to reduced power generation costs. Through the use of He as working medium of the turbine, many problems occurring in operation with steam such as the danger of corrosion and erosion, the problems of drainage, after evaporation, increased activation caused by corrosive products, etc., do not arise. At gas temperatures of 800°C, for which there are already suitable materials available, He turbine power plants of high capacities can achieve net efficiencies up to 50%. Despite these high figures the He turbine still has a development potential as a further increase of the temperature of the working medium is possible and at the same time, other than with steam turbines, relatively low pressures can be adopted. (auth)

42767 HISTORY OF THE NORSE-NETHERLANDS CO-OPERATION IN THE AREA OF NUCLEAR ENERGY. III. Goedkoop, J. A. Atoomenergie Haar Toepass., 9: 97-102 (May 1967). (In Dutch).

The review of design studies made on NUPOP is completed and the design studies of the SUSPOP are outlined. In conclusion, the events of 1955, in which the Reactor Centrum Nederland was established, the First International Conference on the Peaceful Uses of Nuclear Energy was held, and a second agreement made between Norway and the Netherlands, are described. (tr-auth)

42768 COOLING OF A-1 POWER PLANT REACTOR DURING LOW-POWER OPERATIONS. Bis, Jiri (Shkoda Plant, Plzen, Czech.). Jad. Energ., 13: 326-30(1967). (In Czech).

A method is given for approximate calculations of the lifting force influence on gas flow stability in reactor channels, on the fuel element cooling in a reactor with gas downflow at normal operations, and during emergency reactor cooling. (tr-auth)

42769 SIMULATION OF START-STOP PROCESSES OF NUCLEAR REACTORS. Asanbaev, Yu. A.; Berlin, E. M.; Karasev, G. V. At. Energ. (USSR), 22: 498-501(1967). (In Russian).

Design and construction of electronic models for studying the behavior of reactors present problems because during the startup the power level passes through 10 to 11 orders of magnitude but the dynamic range of the electronic systems does not exceed three orders. For processes encompassing 5 orders of magnitude, the problem might be solved by using a logarithmic scale but the required nonlinear converters increase the chances for error. A method based on the kinetic equation was proposed. The system includes a balancing device; it makes possible to take into account all of the delayed-neutron groups and to reproduce processes leading to the increase or decrease of the variable. The control system consisted of a differential amplifier. The system allows the power increase and decrease to be followed in a practically unlimited manner. Studies of reactor startup and shutdown operations revealed that the error in the reactor period determination by means of this electromechanical multiplier block does not exceed 5% for $T > 10$ seconds. (TTT)

42770 RELATION BETWEEN REACTIVITY AND NEUTRON DENSITY IN THE THERMAL REACTOR. Chi, Chang-yul (Seoul National Univ.). New Phys. (Korea), 6: 69-75(Dec. 1966). (In Korean).

A change in the neutron density with time, resulting from a sudden change in the multiplication constant due to alteration in the position of a control rod, removal of fuel and removal of reflector, makes it necessary to solve the kinetic equations of a thermal reactor. The differential equation was solved and the relation between density and time was obtained for certain values of reactivity. (auth)

42771 PLANNING TODAY FOR TOMORROW'S NUCLEAR NEEDS. Dieckamp, H. M.; Falcon, J. A.; Hoffman, B. L. Nucl. News, 10: No. 9, 48-55(Sept. 1967).

Fuel supplies for nuclear power demands are discussed. Projections for fuel costs, available U ore reserves, and fuel requirements through the year 2010 are presented. Types of converter reactors and Pu producing breeder reactors are described. Operational statistics for various reactor projects and performance data are compared. (D.C.C.)

42772 CONCEPTS OF THE FUSED SALT REACTORS "SAWA" AND "WARS" (COMPILATION OF CHARACTERISTICS). Taube, M.; Kowalew, A.; Poturaj-Gutniak, S.; Mielcarski, M. (Inst. of Nuclear Research, Warsaw). Kernenergie, 10: 184-6(June 1967). (In German).

The future development of nuclear power probably rests on the basis of fast reactors. Possibly, the boiling reactor with fused salt fuel and direct cooling will play an important role in this development. A concept of two such reactors is discussed. Their characteristics and some of their properties are compared with each other and with those of fast reactors fueled with non-boiling fused salts. (auth)

42773 NUCLEAR POWER PLANTS AND THEIR TECHNOLOGICAL POSSIBILITIES. Leipunskii, A. I. Kernenergie, 10: 177-81(June 1967). (In German).

Brief discussions are presented on the start of economic use of nuclear power, the construction of advanced reactor types, thermal reactor improvements, fast breeder construction, fuel supply and economics, thorium utilization, and present nuclear power programs. (H.D.R.)

42774 XENON GLOBAL STABILITY. Lellouche, G. S. (Brookhaven National Lab., Upton, N. Y.). J. Nucl. Energy, 21: 519-20(June 1967). (BNL-10847).

The criteria presented by Akcasu et al. [J. Nucl. Energy, 21: 341-9 (1967)] for asymptotic global stability with respect to Xe oscillations in a point reactor with temperature effects is discussed further. It is possible to analyse global stability directly by treating the sum of the terms in the stability criteria as negative, as an alternative to the more restrictive treatment in which each term is taken as negative separately. (UK)

42775 OPERATING EXPERIENCE WITH THE WAGR FUELING MACHINE. Slater, E. (United Kingdom Atomic Energy Authority, Windscale, Eng.). Nucl. Eng., 12: 600-3(Aug. 1967).

The fueling machine design, which is based on single channel access with on-load fueling, is described and its mode of operation summarized. Operating experience over the last four years, which is reviewed, has shown the machine to be extremely reliable. The performance of individual components is discussed. (UK)

42776 TANDEM BWR/BHWR FUELLING. Märgen, P. H.; Haga, I. (Aktiebolaget Atomenergi, Stockholm). Nucl. Eng., 12: 606-9(Aug. 1967).

A study is described of a tendem arrangement of nuclear power plants in which irradiated fuel is passed from a BWR to a BHWR. The engineering design and physics performance are discussed. An economic analysis for 400 MW (e) units compares the costs of BWR, BHWR, and tandem stations, and the tandem arrangement shown to have considerable advantage. (U[illegible])

42777 URANIUM REQUIREMENTS FOR NUCLEAR POWER. Dietrich, J. R. Nucl. News, 10: No. 9, 38-44; 62(Sept. 1967).

A supply and demand study of U fuel for nuclear power requirements is presented. The use of converter reactors is discussed. Fast breeder production figures for Pu under various reactor design criteria are presented. Predicted power requirements and converted fuel supplies are projected from the year 1980 to 2060. A method is described which would meet power and fuel demands for Pu and become independent of fissile U by the year 2055. An economic analysis of breeder reactors including Pu production efficiency, consumption versus production, peak ore requirements, and fuel cycle costs is presented for the period from the year 1980 to 2050. (D.C.C.)

42778 THE COMMISSIONING OF THE NUCLEAR POWER STATION GUNDREMMINGEN. Weckesser, A. (Kernkraftwerk RWE-Bayernwerk GmbH, Gundremmingen, Ger.); Ettemeyer, R.; Knoerzer, G.; Schroeder, H.; Staebler, K.; Haussmann, H.; Mueller, A. Atomwirt. Atomtech., 12: 348-56(July 1967). (In German).

The completion and commissioning of the Nuclear Power Station Gundremmingen in 1966 was the first step in a future German reactor program for large nuclear power stations. With a gross rating of 250 MW(e) this installation is, at the moment, the largest boiling water reactor in operation anywhere in the world. The installation has been supplying power to the public grid since 11th December 1966. Economic judgments are still premature since, in the first phase of commissioning, the proving of the installation has been the focus of attention. On the other hand it can now, in retrospect, be established how far the expectations in respect of expenditure of time and money were fulfilled. The planning and the constructional and technical features of the whole installation were described in detail in the special issue of "Atomwirtschaft" entitled "KRB Nuclear Power Station Gundremmingen." The account is continued in the present issue with articles describing the experience during construction, the building costs and numerous details of the commissioning. Included is experience which will influence the planning standpoint of future nuclear power stations, experience with the course and difficulties of the licensing procedures which offers useful hints to the applicant as well as the licensing authorities and also experience with important components of the plant, with the reactor inspection, the electrical plant and with the water treatment. Experience so far shows that the nuclear technology has caused practically no difficulties, largely perhaps because of the quite special care which is understandably devoted to a new technology. The conventional parts of the installation, on the other hand, attract considerably less attention since here everything appears to be well known. All experience however shows that it is precisely in this area that increased attention must be directed in the future. (auth)

42779 INDUSTRIAL ASPECTS OF THE FAST BREEDER REACTOR PROGRAM. REPORT ON THE THIRD FORATOM CONGRESS IN LONDON. Atomwirt. Atomtech., 12: 373-8(July 1967). (In German).

The proceedings of the 3rd International Congress conducted by FORATOM, and concerned with fast breeder reactors, is summarized. The fast breeder reactor is considered from the industrial point of view. Various aspects of the fast breeder system, such as coolants or fuels, are discussed. The economics of these systems and the feasibility of their use as power plants are discussed.(M.L.S.)

42780 SOME PROBLEMS FOR THE PRODUCTION OF REACTOR CONSTANTS. Nippon Genshiryoku Gakkaishi, 9: 386-95 (July 1967). (In Japanese).

An evaluation of available cross section data is given. The use of computer codes for generation of cross section libraries to be used with reactor calculations is discussed; the cross section accuracy, as calculated by these computer programs, is discussed. (M.L.S.)

42781 CONTAINMENT SHELL FOR A 250 MWe GAS-COOLED HEAVY-WATER REACTOR. Verstraete, P.; Lehmann, D.; Lafitte, R. (Bonnard and Gardel, Lausanne, Switzerland). Nucl. Eng. Design, 5: 486-511(July 1967). (In French).

Several types of containment for a gas-cooled heavy water-moderated reactor (250 MW(e)) are studied with the purpose of defining their cost and efficiency. A description of the two types of reactors studied, one conventional with pressure tubes, the other integrated in a prestressed concrete pressure vessel is presented. A description of the safety features of gas-cooled reactors and a maximum credible accident with 5% fuel melt is defined. The consequences of this accident in the installation and in the neighborhood of the nuclear power plant is described. A review of the standards and prescriptions applicable to nuclear power station accidents and criteria enabling to judge the efficiency of the different containments are set up. A method of calculation of the containment efficiency for the maximum credible accident is presented. The parameter values which are used in the evaluation of the containment efficiency are outlined. The examination of the different outside containments for the conventional reactor from the points of view of civil engineering and cost of construction as well as of safety is presented. The examination of the underground containment with regard to construction program, accessibility during construction, leaktightness, cost and safety is described. A rough description of the features of the integrated reactor is discussed. The efficiency of the various types of containments from the point of view of safety taking into account the auxiliary decontamination installations is presented. For the reactor studied, the prestressed concrete containment enclosure is more expensive than a steel containment is at the upper limit of what may be considered as acceptable under Swiss conditions and the efficiency of both underground containment and prestressed concrete pressure vessel is very good and comparable to that of a double containment. (auth)

42782 THERE ARE NEW TRENDS IN REACTOR SITING. Bender, Rene J. Power, 111: 108-11(Sept, 1967).

Reactor siting criteria are discussed which include engineering safeguards, environmental seismic conditions, meteorological effects, and economics. A list of 32 power stations is given with information concerning population densities in given radial areas of each power plant. (D.C.C.)

42783 NUCLEAR PLANT MAINTENANCE CALLS FOR INGENUITY, SHOWS NEED FOR THOROUGH TESTING. Strauss, S. D. Power, 111: 114-15(Sept. 1967).

Examples of operation improvement and failure prevention by means of component testing are presented for the San Onobre Power Reactor, Peach Bottom Power Reactor, the High-Temperature Gas-Cooled Reactor Experiment, Big Rock Point Power Reactor, Shippingport Pressurized-Water Reactor, and Yankee Power Reactor. (D.C.C.)

42784 NUCLEAR SHIELDING FOR SPECIAL SITUATIONS. Hall, W. Cornelius. Power, 111: 116-18(Sept. 1967).

Special shielding materials and their applications are presented. Shielding problems for exposed pipes, periscope windows, doors, cables, floors, cracks, and ceilings are illustrated and discussed, and a list of various shielding materials is presented. (D.C.C.)

42785 PREOPERATIONAL TESTING EXPERIENCE AT THE SODIUM REACTOR EXPERIMENT-POWER EXPANSION PROGRAM. Peckinpaugh, C. L. (Atomics International, Canoga Park, Calif.). New York, American Society of Mechanical Engineers, 1967, Preprint No. 66-WA/NE-19, 8p., $1.50. (CONF-661102-37). DTIE.

From American Society of Mechanical Engineers, Winter Annual Conference, New York.

Preoperational testing at the Sodium Reactor Experiment-Power Expansion Program is discussed. The overall philosophy of the startup testing program and use of test-procedure summaries to expedite test review and performance are outlined. Preoperational and reliability testing results are reported, including discovery and correction of gas entrainment in the Na heat-transfer system and failure of a Na-pump oil seal which resulted in minor oil leakage into the Na system. The results of Na purification by cold and hot trapping are reviewed. (auth)

42786 NUCLEAR REACTOR. Ashcroft, David John; Hartwell Roy (to United Kingdom Atomic Energy Authority). British Patent 1,083,183. Sept. 13, 1967. Filed Feb. 27, 1964.

The design of a pressurized water reactor with hexagonal fuel elements assemblies is given. Y-shaped control blades of an absorber material are suspended from control mechanism rods between the fuel assemblies. (J.C.W.)

42787 IMPROVEMENTS IN NUCLEAR REACTORS. (to Babcock and Wilcox Ltd.). British Patent 1,083,087. Sept. 13, 1967. Priority date Apr. 11, 1964, Germany.

A nuclear reactor design including a shielded core arranged to be cooled and moderated by water at approximately critical pressure or at a pressure greater than critical pressure is given. Heat exchange tube banks for transfer of heat from the moderating and cooling water to fluid in a secondary circuit are positioned inside the pressure vessel. (J.C.W.)

Marine and Portable Power Reactors

42788 ADAPTATION OF NUCLEAR SPACE POWER PLANTS TO MARINE APPLICATIONS. Johnson, R. A.; Maki, L. M. (Atomics International, Canoga Park, Calif.). pp 783-9 of Advances in Energy Conversion Engineering. New York, American Society of Mechanical Engineers, 1967.

From 2nd Intersociety Energy Conversion Engineering Conference, Miami Beach, Fla., Aug. 13-17, 1967. See CONF-670806.

The modifications to the nuclear reactor-Rankine power systems for space applications to make them suitable for a marine environment are discussed. Descriptive parameters are tabulated for the various degrees of modification. The direct adaptation of a space system, a Pressurized Water Reactor (PWR) with conventional turbomachinery, a PWR with new high-speed turbomachinery, and a Boiling Water Reactor (BWR) with high-speed turbomachinery are covered. A cost comparison of the underwater systems and a discussion of their operation complete the paper. (auth)

42789 LAND-BASED SERVICE STATION FOR NUCLEAR POWERED SHIPS. Meyer-Jungnick, W. (E. Leybold's Nachfolger, Cologne); Salander, C. Kerntechnik, 9: 375-6(Aug. 1967). (In German).

A short review of the design of a land-based station for fuel-element loading and for the maintenance of nuclear powered ships is given. (auth)

42790 COLLISION EXPERIMENTS WITH MODELS OF SHIP COMPONENTS. Woisin, G. (Institut fuer Kernenergie-Schiffsantriebe der Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Geesthacht, Ger.). Kerntechnik, 9: 372-4(Aug. 1967). (In German).

Collision tests made by models are advisable for the development of collision structures for reactor ships. Account of scale effect and simulation of the edge constraint of the ship section models are discussed. (auth)

42791 PROGRAM FOR THE DEVELOPMENT OF AN ECONOMIC NUCLEAR SHIP-PROPULSION SYSTEM WITH AN INTEGRATED PWR DESIGN. Buenemann, D.; Hedemann, H. J. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Geesthacht, Ger.). Kerntechnik, 9: 367-71(Aug. 1967). (In German).

For the development of a competitive nuclear ship propulsion system an advanced integrated pressurized water reactor is considered. The main layout problems are investigated. (auth)

42792 INVESTIGATION OF VARIOUS EFFECTS ON THE LAYOUT PARAMETERS OF THE SATURATED-STEAM PROCESS. Boie, H. (Institut fuer Kernenergieschiffsantriebe der Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Geesthacht, Ger.). Kerntechnik, 9: 361-6(Aug. 1967). (In German).

The parameters of the wet steam process are investigated for the purpose of an economically optimal turbine plant in connection with a pressurized-water reactor provided for a nuclear merchant ship. The efficiency of the whole plant and the corresponding special influences of the saturated-steam circuit are calculated for various steam pressures and temperatures. Curves of efficiency, steam consumption and portion of turbine power are plotted versus steam pressure in different diagrams. The optimal pressure of the saturated-steam process for interesting plant powers results in about 100 at. This is not economically feasible in connection with a pressurized-water reactor. Consequently the results of this investigation are used to establish the optimal layout parameters for the steam generator of the reactor which is the connecting part between primary and secondary system of the whole plant. (auth)

42793 GERMANY'S NUCLEAR RESEARCH SHIP "OTTO HAHN". Ulken, D.; Salander, C. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Geesthacht, Ger.). Kerntechnik, 9: 336-44(Aug. 1967). (In German).

The most important events during the construction of "Otto Hahn" and its nuclear power plant are presented. (auth)

42794 SHIP-PROPULSION REACTORS, STATUS, AND PROSPECTS. von zur Muehlen, M. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Hamburg). Kerntechnik, 9: 334-5(Aug. 1967). (In German).

A retrospective view is given on the 10 year period of marine reactor development in the Federal Republic of Germany. The task of the nuclear research ship "Otto Hahn" being under construction is described. Based on a comparison of nuclear ships and ships with conventional propulsion, consequences with regard to the possible economic operation of nuclear ships are drawn. Special attention is paid to container vessels. Under consideration of the knowable and calculable development potential of marine reactors in the following some 5 years, nuclear propulsion units of 40,000 to 50,000 shaft-horsepower appear to be competitive. Prior to an economic introduction of nuclear marine propulsion, the construction of a first prototype vessel to be ordered by a shipping company seems to be necessary. (auth)

42795 FABRICATION AND MATERIAL TESTING OF THE FUEL ELEMENTS FOR THE ADVANCED PRESSURIZED-WATER REACTOR OF THE NUCLEAR RESEARCH SHIP "OTTO HAHN". Schmitt, F. J. (Institut fuer Kernenergieschiffsantriebe der Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Geesthacht, Ger.). Kerntechnik, 9: 345-50(Aug. 1967). (In German).

A short introduction to the core-construction of the advanced pressurized-water reactor is followed by the description of the manufacture and testing of the various fuel-element components. Destructive and non-destructive testing methods were applied to the following components: UO_2-pellets, cladding-tubes, spacer grids and other structural components. (auth)

42796 DESIGN OF A SHIP-PROPULSION SYSTEM WITH HIGH-TEMPERATURE REACTOR AND HELIUM TURBINE. Donker, B. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Geesthacht, Ger.); Roesner, E. Kerntechnik, 9: 376-81(Aug. 1967). (In German).

The development of ship-propulsion plants based on a He cooled reactor with closed-cycle gas turbine led to a graphite-moderated reactor combined with a freely running power turbine. The small space required, the possibilities of arrangement, high efficiency, and simple operation provide favourable characteristics for a ship-propulsion plant. Technical details of the plant and its installation in a tanker are presented. (auth)

Rocket and Space Reactors

Refer also to abstracts 41101 and 41861.

42797 (NASA-TN-D-4164) ESTIMATES OF LOCAL AND AVERAGE FUEL TEMPERATURES IN A GASEOUS NUCLEAR ROCKET ENGINE. Kascak, Albert F. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Sept. 1967. 29p. CFSTI.

A diffusion analysis is presented of the radiant heat transfer from a centrally located cylinder of gaseous nuclear fuel to a surrounding annulus of flowing hydrogen. Results are shown as radial temperature profiles and integrated average temperatures in the fuel region. Parametric calculations are presented to show the influence on fuel temperature of boundary conditions, radial fuel profiles, fuel ionization and density profiles, the fuel absorption coefficient, reactor pressure, and engine thrust. All calculations are for a specific impulse of 1500 seconds; engine thrust is varied from 10^5 to 10^6 pounds which corresponds to reactor powers from 4000 to 40,000 megawatts. Most results are presented for a thrust of 500,000 pounds and a reactor pressure of 500 atmospheres, but a final set of average fuel temperatures are also presented for pressures of 100, 500, and 1000 atmospheres and a thrust ranging from 10^5 to 10^6 pounds. For a given engine configuration, thrust, specific impulse, and power level, it is shown that boundary conditions of fuel zone edge location and fuel temperature do not significantly affect the average fuel temperature. Fuel ionization and perfect gas density variation with local temperature are likewise relatively unimportant influences on either internal or average fuel temperatures. Using a radially decreasing fuel mole fraction profile in place of a constant radial fuel mole fraction distribution reduces the average fuel temperature from 107,000° to 93,000°R. Results include only the influence of radiative transfer; a significant degree of turbulent heat transport or electron conduction would decrease estimated fuel temperatures. (auth)

42798 REACTOR-POWERED BRAYTON CYCLE FOR LARGE SPACE STATIONS. Pietsch, Anthony (AiResearch Mfg. Co. of Arizona, Phoenix). pp 65-75 of Advances in Energy Conversion Engineering. New York, American Society of Mechanical Engineers, 1967.

From 2nd Intersociety Energy Conversion Engineering Conference, Miami Beach, Fla., Aug. 13–17, 1967. See CONF-670806.

The results of an analysis and design of a Brayton-cycle system, powered by a SNAP-8 type reactor, for a large space station are given. The power system, reactor, and shield are supported by the conical radiator that is also the aerodynamic nose cone of the launch vehicle. Design details of all the major components are presented and the overall design of the system is shown. (auth)

42799 SNAP-8: A TECHNICAL ASSESSMENT. Hodgson, J. N.; Geimer, R. G.; Kreeger, A. H. (Aerojet-General Corp., Azusa, Calif.). pp 135-43 of Advances in Energy Conversion Engineering. New York, American Society of Mechanical Engineers, 1967.

From 2nd Intersociety Energy Conversion Engineering Conference, Miami Beach, Fla., Aug. 13–17, 1967. See CONF-670806.

SNAP-8 is a nuclear electric power conversion system (PCS) designed for operation in space using liquid metals as working fluids. The system is designed to produce a net electrical output of 35 kwe. Data are reported giving the performance of major system components obtained from component development tests. Also, the results of PCS system tests are reported, which show the successful coupling of components into a workable system. Aspects of system performance investigated include system startup, control, and stability. (auth)

42800 ANALYSIS TO DETERMINE THE OPTIMUM HEAT SOURCE TEMPERATURE FOR A POTASSIUM RANKINE CYCLE SPACE POWER PLANT. Leighton, Gerald S. (Atomic Energy Commission, Washington, D. C.). pp 563-74 of Advances in Energy Conversion Engineering. New York, American Society of Mechanical Engineers, 1967.

From 2nd Intersociety Energy Conversion Engineering Conference, Miami Beach, Fla., Aug. 13–17, 1967. See CONF-670806.

The shield/radiator weight tradeoffs are examined as a function of reactor operating temperature for a one megawatt electric potassium Rankine cycle space power plant. Fuel burnup limitations determine the extent to which high reactor temperature can reduce system weight. The study presented is based on the preliminary data available on uranium nitride swelling as a function of burnup and temperature. The results indicate that no significant weight advantage can be realized for maximum cladding temperature above 2400°. (auth)

42801 DESIGN OF A 1 KWE FAST REACTOR POWER SUPPLY. Roberts, John J.; Croke, Edward J. (Argonne National Lab., Ill.). pp 575-86 of Advances in Energy Conversion Engineering. New York, American Society of Mechanical Engineers, 1967.

From 2nd Intersociety Energy Conversion Engineering Conference, Miami Beach, Fla., Aug. 13–17, 1967. See CONF-670806.

A fast spectrum, nuclear reactor power supply has been designed which compared favorably with radioactive isotope sources and SNAP thermal reactors in the 1 to 5 kwe range. The use of a ^{239}Pu-based fuel in a comparatively simple design which employs in-core heat pipes and a heat pipe radiator yields a relatively lightweight and low cost system which should have particularly good intrinsic reliability. The specific weight for the proposed 1 kwe reactor system is about 525 lb/kwe (340 lb/kwe at 5 kwe) vs typical weights of about 1000 lb/kwe for isotope powered supplies in this power range. Unlike competitive isotopes, Pu-239 will be available to meet the anticipated demand for unmanned experimental communication satellites in the 1970's. Moreover, this fuel should cost from 10–20% of the equivalent in isotope power in the 25-125 kwt thermal power range. (auth)

42802 MAN-RATING OF REACTOR POWER SYSTEMS FOR LUNAR-BASE MISSIONS. Greenfield, Harold H. (Lockheed Missiles and Space Co., Sunnyvale, Calif.). pp 679-87 of Advances in Energy Conversion Engineering. New York, American Society of Mechanical Engineers, 1967.

From 2nd Intersociety Energy Conversion Engineering Conference, Miami Beach, Fla., Aug. 13–17, 1967. See CONF-670806.

Application of SNAP-8 type of reactor power system for manned lunar-base operations in the post-1975 period is discussed. The effects of the lunar-base crew and mission interfaces and interactions on the engineering design for the SNAP-8 system are presented. The selection of the power system integration modes, operational philosophy and characteristics, and reliability and maintenance requirements are directly affected by the mission model requirements and the lunar crew's capability to perform on the lunar surface with the equipment, facilities, and life support systems available. The SNAP-8 Program is evaluated on the basis of the ability of SNAP-8 hardware and technology to satisfy the lunar mission requirements. The preferred operational modes and shielding, general reliability, and maintenance philosophies are derived along with the design criteria and the identification of engineering problems and their solutions as effected by the lunar crew and mission. The Rankine-cycle and thermoelectric power-conversion systems—each using the SNAP-8 type of reactor integrated into the Lunar Landing Vehicle (LLV) for the lunar-base mission—are considered, and their performances are compared. (auth)

42803 DESIGN REQUIREMENTS OF A REACTOR-RANKINE POWER SYSTEM FOR A LUNAR-BASE MISSION. Rosenblum, Martin (Lockheed Missiles and Space Co., Sunnyvale, Calif.). pp 689-97 of Advances in Energy Conversion Engineering. New York, American Society of Mechanical Engineers, 1967.

From 2nd Intersociety Energy Conversion Engineering Conference, Miami Beach, Fla., Aug. 13–17, 1967. See CONF-670806.

A semi-permanent manned lunar mission using a nuclear power system imposes special requirements on the power systems. The integration of the SNAP-8 power system with a manned lunar mission is discussed. The emphasis is upon mission integration from an engineering viewpoint, rather than parametric studies. Many of the results and conclusions for the SNAP-8 system are also applicable to other nuclear systems for the manned lunar mission. (auth)

42804 REACTOR AND SHIELD SUBSYSTEMS FOR MORL AND LUNAR BASE POWER PLANTS. Gylfe, J. Donald (Atomics International, Canoga Park, Calif.). pp 699-709 of Advances in Energy Conversion Engineering. New York, American Society of Mechanical Engineers, 1967.

From 2nd Intersociety Energy Conversion Engineering Conference, Miami Beach, Fla., Aug. 13–17, 1967. See CONF-670806.

The results of two studies regarding the application of SNAP 8 type reactors to the Manned Orbiting Research Laboratory (MORL) and manned lunar bases are presented. A brief description and discussion of the current development status and performance capabilities of the SNAP 8 reactor is presented. The results of the MORL study with respect to the reactor, shield, and primary coolant subsystems are reviewed, including discussions of key requirements, parametric studies, selected design concepts, and conclusions. Reactor and shield concepts and tradeoffs for lunar power plants using both SNAP 8 mercury Rankine and thermoelectric power conversion systems are discussed and a 20-kwe SNAP 8 thermoelectric lunar powerplant is described. (auth)

42805 REACTOR AND POWER CONVERSION SYSTEM DESIGN INTEGRATION FOR EARTH ORBITAL APPLICATION.

Ross, F. A.; Chinbrot, C. H.; Plunkett, T. F. (Douglas Aircraft Co., Inc., Huntington Beach, Calif.). pp 711-26 of Advances in Energy Conversion Engineering. New York, American Society of Mechanical Engineers, 1967.

From 2nd Intersociety Energy Conversion Engineering Conference, Miami Beach, Fla., Aug. 13–17, 1967. See CONF-670806.

The results of design integration studies of reactor, shielding, and alternative power conversion system (PCS) concepts to meet the power requirements of a manned Earth-orbital research laboratory designed for 5 years of service is discussed. The SNAP-8 type reactor was selected in combination with the SNAP-8 mercury Rankine, SNAP-2 mercury Rankine, Brayton cycle, direct radiating and compact thermoelectric power conversion systems to produce output power levels of 10, 20, and 30 kWe. Principal consideration was given to the requirements of man-rated system designs for prolonged service in space. On the basis of a parametric design analysis, a SNAP-8 type reactor capable of 600-kWt nominal at 1,300°F coolant outlet temperature for a 5-year life-time was selected for all systems. Although 4π shielded configurations were investigated, the lower weight shadow shield design was selected as entirely satisfactory to meet mission requirements. From the evaluation of basic design alternatives, integrated PCS designs were evolved which are compatible with all mission requirements and are within the limits of present technology. System reliability and lifetime objectives were attained through installed redundancy and the capability for system replacement during the mission. It was concluded that each power conversion concept investigated can be effectively integrated with the SNAP-8 reactor to satisfy all laboratory functions and mission objectives, and to provide the potential for increased capability and growth. Areas requiring a focused development effort were identified. (auth)

42806 REACTOR POWER SYSTEMS FOR MANNED EARTH ORBITAL APPLICATIONS. Gervais, R. L.; Kirkland, V. D. (Douglas Aircraft Co., Huntington Beach, Calif.). pp 727-38 of Advances in Energy Conversion Engineering. New York, American Society of Mechanical Engineers, 1967.

From 2nd Intersociety Energy Conversion Engineering Conference, Miami Beach, Fla., Aug. 13–17, 1967. See CONF-670806.

Design requirements for integration of reactor power systems with a manned Earth orbital space station are given. The power conversion concepts investigated include the SNAP-8 type reactor combined with the SNAP-8 and SNAP-2 Hg Rankine systems, Brayton cycle, and direct radiating and compact converter thermoelectric systems. Modifications of mission parameters for integration of a reactor power system with the MORL include: orbit altitude optimization for low inclination and polar orbit missions, resizing of control moment gyros and modification of the reactor control system, increased length to provide environmental control and life support radiator area to reject the entire power load, selection of a 5.5 KWE ^{238}Pu Brayton cycle system as standby/emergency power source, and redefinition of launch vehicles and launch systems. (M.L.S.)

42807 NUCLEAR BRAYTON CYCLE POWER PLANTS FOR SPACE APPLICATIONS. Freedman, S. I.; Keiser, J. T.; Cohen, R. M.; Terrill, W. R. (General Electric Co., Philadelphia). pp 749-69 of Advances in Energy Conversion Engineering. New York, American Society of Mechanical Engineers, 1967.

From 2nd Intersociety Energy Conversion Engineering Conference, Miami Beach, Fla., Aug. 13–17, 1967. See CONF-670806.

A parametric analysis and system optimization was made of reactor heated Brayton cycle space powerplants in the 50 to 200 KWe range. Turbomachinery performance was based on the efficiencies of the NASA/Lewis two-shaft solar Brayton cycle system, and on a growth machine at a lower pressure level. Dependence of optimized system specific weight on turbine inlet temperature and power rating was determined. In order to determine the effects of reactor shielding requirements on powerplant weights, two types o applications were considered: an unmanned mission requiring shadow shielding, and a manned space station application in which sculptured wrap around shielding was needed. Emphasis was placed on the nuclear reactor heat source, the radiator, and powerplant arrangements as they are influenced by spacecraft integration requirements. Parametric evaluation was made of various system configurations, including single-, two-, and three-loop arrangements with different combinations of liquid and gas cooled reactors and radiators. Parametric models of all major powerplant subsystems, gas and liquid-metal cooled reactors, shields, turbomachinery, heat exchangers, gas ducting, and gas and liquid-metal filled radiators were synthesized. Effects of lower turbomachinery pressure levels investigated indicate that if gains in turbine and compressor efficiency could be obtained, the use of lower pressure levels are more than offset by the large and heavier components required, except in three-loop systems for unmanned application. Results include weight and component specifications of minimum weight powerplants. (auth)

42808 NUCLEAR ROCKET ENGINE CONTROLS. Sheridan, E. A. (Aerojet-General Corp., Sacramento, Calif.); Kirschbaum, H. S. New York, American Institute of Aeronautics and Astronautics, 1966, Preprint No. 66-1005, 10p., $1.50. (CONF-661124-2). DTIE.

From 3rd AIAA Annual Meeting, Boston.

A nuclear rocket engine requires controls for reactor power, nozzle chamber temperature and pressure. Control of these parameters is required during three phases of operation. During Startup and Bootstrap nuclear power is brought from neutron source power level to an intermediate level by open loop programming. At this point, the power range controllers are used to initiate the flow of coolant and increase reactor power until chamber temperature and pressure are increased to a predetermined level. The Power Range phase of operation is then begun. Pressure control in the Power Range is accomplished by positioning the valve which regulates drive gas to the turbopump with a closed loop controller. The temperature has historically been controlled with a closed loop temperature controller which works through an inner nuclear power loop to position the control drums. Recent experiments have demonstrated that the inner power loop may be omitted and also that temperature changes may be controlled by varying the coolant flow. This is feasible because of the basic stability of the nuclear engine. It has resulted in startups to operating power with fixed control drum position. The third phase of operation consists of Shutdown and Cooldown. This phase uses different controllers to introduce coolant which then removes the reactor decay heat. (auth)

42809 MULTIPLE EXHAUST NOZZLES FOR NUCLEAR ROCKET ENGINES. Vanica, D. F.; Duke, E. E. (Aerojet-General Corp., Sacramento, Calif.). New York, American Institute of Aeronautics and Astronautics, 1966, Preprint No. 66-925, 10p., $1.50. (CONF-661124-3). DTIE.

From 3rd AIAA Annual Meeting, Boston.

Results of theoretical and experimental studies conducted to evaluate the performance of nuclear rockets using multiple exhaust nozzles are presented. Analytical procedures for nozzle design and performance predictions are developed. Aerodynamic efficiency of the experimental model is shown to be lower than an equivalent single nozzle because of the thrust vector cosine losses; however the concept offers a significant advantage in vehicle payload capacity when applied to nuclear rockets. Convective cooling requirements are reduced by using refractory nozzle materials so that less pump work is required, hence less turbine bleed flow, which increases the available propellant for thrust conversion. Also, less heat is extracted from the exhaust gases because of the reduced cooling requirements. The most significant advantages, however, are the performance gain which occurs because of the high temperature capability of the refractory nozzles and the greater propellant capacity for the same overall stage length as a result of shortening the engine. (auth)

Research and Test Reactors and Critical Assemblies

Refer also to abstracts 41115, 41117, 41292, and 42642.

42810 (AD-645546) A BRIEF DESCRIPTION OF THE AFRRI-TRIGA MARK F REACTOR METHODS FOR CONTROLLING DISCHARGES, ENVIRONMENTAL SURVEILLANCE AND EMERGENCY PLANS. Porter, S. W.; Verrelli, D. M. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). July 1966. 23p. (AFRRI-SP-66-17). CFSTI.

The Armed Forces Radiobiology Research Institute Triga Mark F Reactor and associated experimental facilities are briefly described. A unique perimeter monitoring system is discussed. The remote area monitoring system along with the radioactive liquid and gaseous handling and waste disposal systems are outlined. A brief discussion of emergency procedures is included. (auth)

42811 (AECL-2527) THE CHEMISTRY OF THE X-7 (ORGANIC) LOOP COOLANT, MAY 1960–APRIL 1965. PART I. Smee, J. L. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Jan. 1966. 86p. Dep. CFSTI. CAN $2.00.

The X-7 coolant chemistry from the start of loop operation in May 1960 to April 1965 is described. During this period the coolant

was Santowax OM containing a nominal 30% high boilers or high-molecular-weight decomposition products. During the first few months of operation it became apparent that there was a serious problem in the fouling of fuel element heat transfer surfaces. This was overcome by continuous purification of the coolant by Attapulgus clay and filters. Since clay purification has been in use, the fouling rate has been less than 0.2 $\mu g \cdot cm^{-2} \cdot h^{-1}$ (10 μm per year), the target value for successful operation of an organic-cooled power reactor. Control of the fouling promoter chlorine was accomplished by completely excluding it from the vicinity of the loop. Any that does get into the coolant is removed by a bed of Mg ribbon and Pd pellets. Since such a bed has been in use, the Cl content of the coolant has been less than 3 ppM. (auth)

42812 (AECL-2654) THE CHEMISTRY OF THE X-7 (ORGANIC) LOOP COOLANT, APRIL 1965-MAY 1966. PART II. Smee, J. L. (Atomic Energy of Canada Ltd., Pinawa (Manitoba)). July 1966. 15p. Dep. CFSTI. CAN $0.50.

The coolant chemistry during X-726 fuel irradiation is described. This was the first fuel irradiation in HB-40. The fouling potential remained $\leq 0.2\ \mu g \cdot cm^{-2} \cdot h^{-1}$ throughout the test and other impurities were acceptably low. The high boiler content increased from 2 to 12% during the irradiation. No problems were encountered during the changeover from Santowax OM to HB-40. (auth)

42813 (IS-1600, Paper 7) REACTOR DIVISION. Spedding, F. H.; McCorkle, W. H.; Crudele, J. S.; (and others) (Ames Lab., Iowa). 48p.

AMES RESEARCH REACTOR — fuel elements for, burnup analyses of; core for, physics measurements on cold-clear second; data acquisition systems for, use of computer as; control instrumentation for, modification of remote; safety instrumentation for, design of modifier; cryostat facility for, development of

REACTOR FUEL ELEMENTS — burnup determination of Ames Research

LEAK DETECTORS — use of scintillation crystal and photomultiplier γ-detection on system in Ames Research Reactor for

VOLTMETERS — use in Ames Reserach Reactor of integrating

DIFFRACTOMETERS — modification of Ames Research Reactor double neutron

ELECTRONIC EQUIPMENT — development for Ames Research Reactor of torsional pendulum

RADIATION DETECTORS, SEMICONDUCTOR — design for Ames Research Reactor; fabrication of Ames Research Reactor

DATA ACQUISITION SYSTEMS — use for radioactivity counting at Ames Research Reactor

GONIOMETERS — development of Ames Research Reactor heavy duty

CRYOSTATS — development for Ames Research Reactor of

RADIATION DETECTORS, CHEMICAL — use for gamma flux measurements in Ames Research Reactor

GAMMA RADIATION — flux measurements in Ames Research Reactor, use of Fricke dosimeters for

NEUTRONS, THERMAL — flux measurements in Ames Research Reactor; spectra measurements in Ames Research Reactor, design of time-of-flight chopper for

ION BEAMS — instruments for stabilization of Ames Research Reactor, design of

NEUTRONS — beam measurements in Ames Research Reactor using modified x-ray diffraction camera

NEUTRONS, DELAYED — spectral measurements in Ames Research Reactor of, design of pulse rise time discriminator for; half-life determination of, design of spectrum multiscale system for; emission from gaseous fission products, isotope separator for use on-line with Ames Research Reactor for analysis of

SCALERS — design for use with Ames Research Reactor (M.L.S.)

42814 (KFK-542) BESTIMMUNG REAKTORPHYSIKALISCHER PARAMETER AUS DEM REAKTORRAUSCHEN DURCH ANALYSE VON WAHRSCHEINLICHKEITSVERTEILUNGEN. (Determination of Reactor Physics Parameters from the Reactor Noise by Analysis of Probability Distributions). Stegemann, Dieter H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Jan. 1967. 69p. (In German). Dep.

The determination of characteristics such as decay constant of prompt neutron flux, the neutron lifetime, the reactivity, and the absolute reactor power was determined from the analysis of the reactor noise. Difficulty lies in the development of new methods for the determination of probability distributions in the fast-thermal Argonaut reactor STARK. The theoretical principles of the method, beginning with the generalized equations, were treated in the approximation of the point reactor model. Two different methods were developed to obtain the reactor parameters desired from the measured probability distribution; first, the use of distribution moments, and second, the direct calculation of the distribution formed by the individual probabilities. A new type of probability distribution analyzer was developed for carrying out the experiments. Its construction and operation were described in detail. The research program had two purposes. One consisted in the testing of the method which proved satisfactory and additional results were obtained which showed the applicability of the distribution analysis in Pu-charged fast-zero energy critical assemblies. The other concerns the establishment of valid assumptions for the investigation of coupled-reactor systems. Effects which were given by varying types of detector positionings were therefore studied. A valid arrangement was obtained for the elimination of perturbing azimuthal and radial harmonic consituents. The reactor parameters obtained from the analysis of the probability distribution were compared with the measurements of other independent methods and show good agreement. (tr-auth)

42815 (NP-16838) ESSAIS EXTENSOMETRIQUES SUR LE CUVELAGE MELUSINE. (Extensometric Studies on the Melusine Tank Liner). Technical Note 65-24. Parayre, C.; Galtier, J. M.; Perreau, R. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Oct. 1965. 39p. (In French). Dep.

Stress measurements were made on the air tight covering of the Melusine swimming pool and its junctions with channels. The measurements were made at certain critical points. The maximum stress was found in the horizontal diametric plane of the channel junctions. (J.S.R.)

42816 (ORNL-TM-1779) TSR-II HEAT TRANSFER. Lewin, J.; Holland, L. B. (Oak Ridge National Lab., Tenn.). July 26, 1967. Contract W-7405-eng-26. 33p. Dep. CFSTI.

The temperature distribution in the fuel elements of the TSR-II has been calculated for a measured power distribution for the nominal operating conditions of a power level of 2 MW and a total cooling-water flow rate of 800 gpm. The distribution was also obtained for operation at a 3-MW power level and a total flow rate of 400 gpm. Under the latter conditions the maximum fuel plate temperature was 258°F, well below the saturation temperature of the water in the core, which is 283°F at the minimum core pressure of 36.5 psig. (auth)

42817 (PEL-146) HIGH FLUX NUCLEAR RESEARCH REACTORS: ARE THEY ONLY "PRESTIGE" STRUCTURES OR DO THEY REALLY FILL AN URGENT NEED. De Lange, P. W.; Delattre, P. (Atomic Energy Board, Pelindaba (South Africa)). Mar.1967. 21p. Dep.

A survey of high flux test or research reactors is presented. Various uses of these reactors are discussed. Reactors having a neutron flux from (10^{14}-10^{15}) n/cm^2-sec and those having fluxes greater than 10^{15} n/cm^2-sec are presented in tabular summary. 14 references. (M.L.S.)

42818 (RT/FI-(67)15) CALCOLO DI SPETTRI NEUTRONICI CON CODICI ETEROGENEI IN REATTORI TERMICI. (Calculation of Neutron Spectra in Thermal Reactors by Means of Various Codes). Orestano, F.; Pistella, F. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1967. 30p. (In Italian). Dep.

In order to study and interpret experimental data on water moderated Pu lattices, a particular method for neutron spectra evaluation has been developed by coupling different existing codes. Comparison between the experimental and calculated values relative to RANA and RITMO reactors is presented. (auth)

42819 (SRRC-12/66) THERMAL NEUTRON FLUX DISTRIBUTIONS IN SIMULATED REACTOR LATTICES: A COMPARISON BETWEEN THEORY AND EXPERIMENT. Bennet, D. J. (Scottish Research Reactor Centre, East Kilbride (Scotland)). [nd]. 33p. Dep.

A simulated reactor lattice has been made with plates of natural uranium and blocks of perspex to simulate the moderator. This assembly has been irradiated in the thermal column of the UTR-100 reactor in a central region where the neutron flux is nearly uniform, and the variation of thermal neutron flux in the assembly has been measured using dysprosium foils. This flux variation has been compared with the P-1 and P-3 approximate solutions of the neutron transport equation. Experimentally determined values of the disadvantage factors have also been compared with theoretical values. The results show that neither the P-1 nor P-3 solutions agree exactly with the experimental results, particularly near the interfaces between the uranium and the perspex, and in the uranium itself, but as is expected, the P-3 solution gives better agreement than the P-1 solution. 14 references. (auth)

42820 EXPERIMENTAL DETERMINATIONS OF THE STATISTICAL DYNAMICS OF ISPRA-1 REACTOR. Garroni, A.;

Lucia, A.; Sciuto, F. (CCR-EURATOM, Ispra, Italy). Energia Nucl. (Milan), 14: 465-72(Aug. 1967).

The reactor transfer function and neutron noise measurements made on ISPRA-1 reactor in order to establish the excitation source characteristics are presented. The noise r.m.s. amplitude is related to the reactor power, and the probability density of the noise is shown to be nearly gaussian. Some hypotheses on the nature of the noise source are discussed. (auth)

42821 AN EXPERIMENTAL STUDY OF COLD MODERATORS IN THE REACTOR R1. Persson, P. (Royal Inst. of Tech., Stockholm). J. Nucl. Energy, 21: 701-12(Sept. 1967).

An experimental study of 18 cold moderator combinations was performed in a 34-cm diameter channel in the thermal column of the heavy water reactor R1. Moderators investigated were methyl alcohol, pentane, pentanol, light water and heavy water. All the moderators were cylinders of diameter 32 cm and the following thicknesses were used: 0.5, 1, 2, 3.5, 8, 12, and 20 cm. The moderators were cooled to 85°K by liquid N_2. A time-of-flight spectrometer was used for the analysis of the neutron spectra. The purpose of the experiments was to investigate the most efficient cold moderator for permanent installation in the reactor. The experimental data show that the greatest gain factor obtained at the neutron wavelength 4 Å is 2.9. This gain factor was obtained by use of a methyl alcohol or a pentane moderator at a thickness of 1 cm. The results are in disagreement with results predicted and obtained in experiments by some other authors. A discussion of factors causing the disagreement is given. (auth)

42822 FACILITY FOR ZERO-POWER EXPERIMENTS WITH LIQUID-MODERATED CORES. Henning, K.; Salander, C.; Ulken, D.; Wrobel, H. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Geesthacht, Ger.). Kerntechnik, 9: 350-4(Aug. 1967). (In German).

The zero-power-experiment facility for the performance of zero-power or critical experiments with liquid-moderated reactor cores, which will be used for measurements at the advanced pressurized-water reactor designed and built by the working group Babcock/Interatom for the nuclear ship "Otto Hahn" is described. The design of the new installation is presented. (auth)

42823 MEASUREMENT OF THE COEFFICIENTS OF THE COOLANT FLUID IN THE FAST NEUTRON CRITICAL ASSEMBLY SNEAK. Durand-Smet, R. (de la Societe Indatom). Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.), No. 65, 47-62(1967). (In French).

A brief description is given of SNEAK reactor. The coolant coefficient is defined. The principal problems in the reactor are described and the calculations made to resolve them. These problems are different for Na and water vapor. The problems posed by the limitation of the measurement zone and by the necessary presence of an enrichment zone containing ^{235}U was examined in the case of a 1700-L reactor cooled with Na. The problems posed by the measurement of the coolant coefficients in the presence of a significant quantity of ^{240}Pu or fission products was examined for a steam cooled 700-L reactor. (tr-auth)

42824 MEASUREMENT OF THE PROMPT NEUTRON DECAY CONSTANT OF THE NORA REACTOR BY THE INTERVAL DISTRIBUTION TECHNIQUE. Babala, Dusan; Ogrin, Rudolf (Institutt for Atomenergi, Kjeller, Norway). Nucl. Sci. Eng., 29: 367-72(Sept. 1967).

The prompt neutron decay constant of the NORA reactor for a number of subcritical states has been determined by means of count-interval distribution measurements. The theoretical model agrees well with the experimental results. The technique has been compared with the Feynman and Mogilner methods. With the count-interval distribution technique, a better accuracy of the results has been achieved in a shorter time of measurement, as expected from the theory. (auth)

42825 DANCOFF CORRECTION IN SQUARE AND HEXAGONAL LATTICES. Carlvik, I. (Aktiebolaget Atomenergi, Stockholm). Nucl. Sci. Eng., 29: 325-36(Sept. 1967).

The results of a series of calculations of Dancoff corrections for square and hexagonal rod lattices are presented. The tables cover a wide range of volume ratios and moderator cross sections. The results were utilized for checking the approximative formula of Sauer and also the modification of Bonalumi to Sauer's formula. The modified formula calculates the Dancoff correction with an accuracy of 0.01 to 0.02 in cases of practical interest. Calculation have also been performed on square lattices with an empty gap surrounding the rods. The results demonstrate the error involved in treating this kind of geometry by means of homogenizing the gap and the moderator. The calculations were made on the Ferranti Mercury computer of AB Atomenergi. Since then, FORTRAN routines for Dancoff corrections have been written, and a subroutine DASQHE is included. (auth)

42826 CONSISTENT HETEROGENEOUS THEORY OF REFLECTED LATTICES. Auerbach, T. (Eidgenossisches Institut fuer Reaktorforschung, Wurenlingen, Switzerland). Nucl. Sci. Eng., 29: 317-24(Sept. 1967).

The lattice of a critical or subcritical system is represented by an array of finite cylindrical elements, arbitrarily distributed throughout a cylindrical volume of moderator. The flux in each element is determined from multigroup P_N theory, whose asymptotic part in the moderator, that part of the flux which survives in the moderator at distances of a few mean-free-paths from the element, can readily be identified. The P_N-corrected multigroup diffusion equation is solved in the moderator, taking full account of lattice geometry. It is then connected to the asymptotic part of the interior P_N solution across each individual element-to-moderator interface. Thus the physical requirement that the angular neutron distribution be continuous across all interfaces is satisfied throughout the lattice. A similar approach is employed to make the distribution continuous across the moderator-to-reflector boundary. The theory yields a neutron spectrum which changes continuously, both radially and azimuthally, across the lattice. The method is consistent in that it determines fuel characteristics in accordance with this changing spectrum without the need for defining cells or extrapolation lengths. 10 references. (auth)

42827 MEASUREMENTS OF THE ρ^{28} FACTOR IN NATURAL URANIUM, D_2O MODERATED, AND DIPHYL COOLED LATTICES. Canalini, D.; Cecchi, P. F. (CNEN, Bologna). Energ. Nucl. (Milan), 14: 544-5(Sept. 1967).

Measurements of the epicadmium-to-thermal ratio neutron capture by uranium-238 in the RB-1 pile and a reference position in the thermal column of the RB-2 reactor are performed. (J.C.W.)

42828 THE ATHENE REACTOR OF THE EINDHOVEN TECHNICAL HIGH SCHOOL. Bogaardt, M.; Brouwers, A.; van Hulst, G. Atoomenergie Haar Toepass., 9: 140-7(June 1967). (In Dutch).

The ATHENE is a highly enriched reactor cooled and moderated by light water with a graphite reflector. The characteristics of the reactor are tabulated. Other aspects of the reactor such as reactor physics, irradiation facilities, shielding, coolant system, instrumentation, and reactor vessel are considered. (J.S.R.)

42829 THE FAST FLUX TEST FACILITY. Albaugh, F. W. Nucl. News, 10: No. 9, 45-7(Sept. 1967).

A description of the Fast Flux Test Facility is presented. The need for breeder reactor development is discussed, and comparisons of reactor types and breeding efficiencies are presented. Core configuration, experimental facilities description, and operational statistics for the FFTF are presented. (D.C.C.)

42830 NEUTRON DOSIMETRY IN REACTOR IRRADIATION EXPERIMENTS. Wright, S. B. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Energy, 98-103(July-Aug. 1967).

A review is presented of methods of measuring and calculating the neutron energy spectrum in reactor irradiation experiments and the intensity of the spectrum as a function of time or its integral. (UK)

42831 REACTOR POWER EXCURSIONS. Flower, K. A. Manchester, Eng., Univ. of Manchester, 1967. 183p.

Thesis.

The inherent shutdown mechanisms in Spert-I type high enrichment, light water moderated and reflected reactor cores was investigated. A theoretical treatment is presented for five possible ways in which a reactor may be self-limiting. An experimental investigation of the void coefficient of reactivity is also described, using the Joint Universities Research Reactor at Risley (UKAEA). A reactor power prediction model is formulated, based on average core parameters, and computations from this model, obtained by an Atlas digital computer program, are presented. It is shown that a reasonable estimate of dangerous short period power excursions can be obtained from the model. (UK)

42832 ANALYSIS OF TEMPERATURE AND PRESSURE WITHIN THE CONTAINMENT STRUCTURE OF THE FAST REACTOR TEST FACILITY (FARET). Charak, Ira (Argoe National Lab., Ill.). New York, American Society of Mechanical Engineers, 1967, Preprint No. 66-WA/NE-7, 6p., $1.50. (CONF-661102-35). DTIE.

From American Society of Mechanical Engineers, Winter Annual Conference, New York.

The temperature distribution and pressure within the containment structure of the Fast Reactor Test Facility (FARET) following a postulated maximum credible accident were calculated in order to establish design criteria for the containment and evaluate offsite radiological doses following the subsequent release of radioactivity.

Pessimistic assumptions resulted in the conclusion that the peak internal pressure would be 4.3 psig and the peak temperature of the inner steel containment liner would be 277°F. The total integrated fission product leakage from the containment was 21% of the total fission product inventory. (auth)

42833 CROSS-SPECTRAL DENSITY MEASUREMENTS IN A COUPLED-CORE REACTOR. Hendrickson, Richard Allan. Ames, Iowa, Iowa State Univ. of Science and Tech., 1966. 78p. Thesis.

A method is developed to determine the ratio of the reactivity coupling coefficient to the mean generation time in a two-slab reactor based on experimental measurements of the inherent reactor noise spectrum. A matrix formulation of the cross-spectral density function of the fluctuating neutron density at two experimental access locations adjacent to the cores is used in conjunction with a two-point-reactor model to show that the real part of the cross-spectral density vanishes at a particular frequency, termed the sink frequency. The sink frequency is found to be a function of the ratio of the reactivity coupling coefficient to generation time in the cores and the times required for neutron disturbances to travel between the cores and between the cores and the detector locations. Experimental results verify the predicted behavior of the cross-spectral density function in the neighborhood of the sink frequency and provide an at-critical measurement of the reactivity coupling coefficient of the UTR-10 reactor. (auth)

Reactor Components, Fuels and Accessories

Refer also to abstracts 40770, 41004, 41189, 41298, 41544, 41637, 41674, 42500, 42522, 42611, and 42616.

42834 (MLM-1424) PACKING OF PARTICLES. Gilman, W. S. (Mound Lab., Miamisburg, Ohio). Dec. 29, 1966. Contract AT(33-1)-Gen-53. 7p. Dep. CFSTI.

Information in reactor fuels and other fuels where particulate fuels are employed is compiled. A listing of 34 references is given. (J.C.W.)

42835 (TRG-Report-1489) BATCOST: A COMPUTER CODE FOR PRESENT-WORTH FUEL COST CALCULATIONS. Burstall, R. F. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). Apr. 25, 1967. 16p. Dep. CFSTI. UK 2s. 6d.

A description of the IBM 7090 computer code BATCOST is given. The code performs calculations of fuel cost using the UK present worth method. (auth)

42836 THERMOELECTRIC NUCLEAR FUEL ELEMENTS. MacDonald, R. D. (Atomic Energy of Canada Ltd., Chalk River, Ont.). pp 791-800 of Advances in Energy Conversion Engineering. New York, American Society of Mechanical Engineers, 1967.

From 2nd Intersociety Energy Conversion Engineering Conference, Miami Beach, Fla., Aug. 13-17, 1967. See CONF-670806.

A direct conversion device operating inside a reactor fuel element and using the thermoelectric properties of the fuel may be an attractive way to obtain electricity from nuclear energy. The conversion efficiency depends on the product $(Z)(\Delta T)$ where Z (the figure of merit) is a property of the thermoelectric materials and ΔT is the temperature range of their operation. For a "power topping" application $(Z)(\Delta T)$ should exceed 0.05; therefore, a "ceramic" fuel with a ΔT of 1000 deg C, must have a $Z > 5 \times 10^{-5}$ deg^{-1}. The feasibility of operating a thermoelectric fuel element was demonstrated by a two-month irradiation of elements containing UO_2-Mo cells connected in series. (auth)

42837 COMPARATIVE MEASUREMENTS OF URANIUM ATOM EMISSION FROM FISSIONING SURFACES. Peterson, P. J.; Thorpe, M. M. (Los Alamos Scientific Lab., N. Mex.). Nucl. Sci. Eng., 29: 425-31(Sept. 1967).

Measurements of the rate of U atom emission from a fissioning surface were made on U and UO_2 sources. A technique was employed in which the sources could be maintained in vacuo at all times during the experiments. It was found that at the start of an experiment the rate of emission was high, but declined with increasing reactor exposure to a low constant value of ≈6 U atoms ejected per fission fragment penetrating the surface for the metal and ≈38 for UO_2. Exposure of a U metal source to moist He, after a constant emission rate was achieved, led to a suddenly increased rate that tended to return to that obtaining before treatment. (auth)

42838 THE EL-X8 COMPUTER OF THE RCN. Struch, H. P. Atoomenergie Haar Toepass., 9: 110-20(May 1967). (In Dutch).

The EL-X8 computer of the RCN at Petten is described. The basic concepts of the computer are given. The memory core, the central computer, the background memory, and the control system are discussed. The programming is described. (J.S.R.)

42839 ON THE ANALYTICAL DETERMINATION OF THE THERMAL FIELD IN THE RODS OF PRESSURIZED WATER NUCLEAR REACTORS. Rama, Silvio. Termotecnica (Milan), 21: 351-5(July 1967). (In Italian).

The determination of the thermal field, which accounts for the temperature dependence of the mean thermal conductivity of fuel elements is given. The expression for the field results in a definition of a rapidly converging series involving the power, which depends on the number of aligned bars of U or UO_2. A diagram of temperature as a function of thermal field is given for the two materials. (tr-auth)

42840 INVESTIGATION ON THE HEAT TRANSFER BETWEEN FUEL AND CLADDING AND ON THE INTERACTIONS BETWEEN FUEL AND CLADDING DURING SHORT-DURATION IRRADIATIONS UNDER BOILING WATER REACTOR CONDITIONS. Schwarzwaelder, R. (KRT Kernreaktorteile GmbH, Grosswelzheim, Ger.). Atomkernenergie, 12: 343-56(1967). (In German).

A total of 93 fuel rods of various designs have been irradiated in a pressure tight capsule under boiling water reactor conditions and have been examined in hot cells afterwards. The heat transfer between fuel and clad has been evaluated using fuel rods with stainless steel cladding with diametral gaps ranging from 0.050 to 0.400 mm and with He, Ar, and Xe as a filling gas. The radial thermal expansion of the fuel during operation and the radial deformation of the cladding have been investigated using numerous fuel rods of various designs. Interesting observations are reported and interpreted on the circumferential ridges which have been found more frequently than expected at the pellet interfaces. The axial thermal expansion of the fuel during operation, the axial deformation of the cladding, and the axial relative movement between fuel and cladding have been examined using axial movement detectors within the fuel rods. All test results are reviewed critically and are compared with analytical models and with the findings in the literature. (auth)

42841 IMPROVEMENTS RELATING TO FUELING MACHINES FOR NUCLEAR REACTORS. Collier, Derek (to Fairey Engineering Ltd.). British Patent 1,083,460. Sept. 13, 1967. Filed Feb. 4, 1963.

A power-driven fueling machine designed for servicing vertical fuel channels and control channels in the core of a nuclear reactor is given. (J.C.W.)

42842 STEELS FOR NUCLEAR POWER PLANTS. (to Gustahlwerk Witten A.G.). French Patent 1,180,223. Dec. 29, 1958. Priority date July 27, 1956, Germany.

Parts of nuclear power plants which are exposed to neutron radiation are made of steel alloyed with 0.5 to 10% Be or Zr and has a carbon content of 0.02 to 2.1%. (NPO)

42843 NUCLEAR FUEL MATERIAL AND ITS METHOD OF PREPARING. (to CEA). French Patent 1,424,522. Dec. 6, 1965. Filed Dec. 2, 1964.

A compound $U_3C_2Si_3$ is stated to have better mechanical and thermal properties, for a nuclear fuel, than uranium oxides, carbides, or nitrides. The $U_3C_2Si_3$ is prepared by melting and casting a mixture of U, C, and Si, and heat treating at 1650°C for 50 to 100 hr. (P.G.C.)

GENERAL

42844 (BNL-11516) CONSIDERATION IN THE DESIGN OF A MULTIPLE COMPUTER SYSTEM WITH EXTENDED CORE STORAGE. Fuchel, Kurt; Heller, Sidney (Brookhaven National Lab., Upton, N. Y.). June 1967. 32p. (CONF-671003-1). Dep. CFSTI.

From ACM Symposium on Operating System Principles, Gatlinburg, Tenn.

The recent innovation of the use of large quantities of addressable (but not executable) fast random access memory in order to heighten the multi-programming performance of a multicomputer system is discussed. The general design of the hardware arrangement and the software components and functions of such a system are based on Brookhaven's future configuration of dual CDC 6600's sharing one million words of Extended Core Storage. In the generalization of such a design, special emphasis is placed on estimating expected gains compared to the traditional configuration of separate and independent computers without ECS. An observation is made on the use of conventional slower speed random access storage devices in place of the faster memory. (auth)

42845 (IS-1600) ANNUAL SUMMARY RESEARCH REPORT, CERAMIC AND MECHANICAL ENGINEERING, CHEMICAL ENGINEERING, CHEMISTRY, MATHEMATICS AND COMPUTER SCIENCE, METALLURGY, PHYSICS, AND REACTOR DIVISIONS, JULY 1, 1966-JUNE 30, 1967. (Ames Lab., Iowa). Mar. 1, 1967. Contract W-7405-eng-82. 402p. Dep. CFSTI.

The annual report of Ames Laboratory contains reports on the following topics: ceramic and mechanical engineering, chemical engineering, chemistry, mathematics and computers, metallurgy, physics, and reactors. Separate abstracts are prepared for each section. (M.L.S.)

For abstracts of individual sections see: 40772, 40957, 41575, 41650, 42278, 42813, and 42846.

42846 (IS-1600, Paper 4) MATHEMATICS AND COMPUTER SCIENCE DIVISION. Spedding, F. H.; Maple, C. G.; Carlson, B. C.; Korthoven, P. J. M.; Fitzwater, D. R.; Lambert, R. J.; Sage, C. R.; Stewart, R. M. Jr. (Ames Lab., Iowa). 10p.

Research programs are reported on computer control systems and theory, mathematics, and computer programming. (B.G.D.)

42847 (K-L-6171) SPECIFIC GRAVITY DIGITAL RECORDER OPERATION AND MAINTENANCE MANUAL. Kermicle, H. A.; Farquharson, J. (comp.) (Oak Ridge Gaseous Diffusion Plant, Tenn.). Aug. 29, 1967. Contract W-7405-eng-26. 21p. Dep. CFSTI.

The design and operation of a specific gravity digital recorder is presented. The system has a range of 0.900 to 2.100 sp gr with a resolution of ±0.001 sp gr. It is specifically designed for the rapid analysis of gradient samples from liquid centrifuges. (W.H.K.)

42848 (LA-3727) EVALUATION OF LENSES FOR USE IN ALL-SKY PHOTOMETERS. Barasch, Guy E. (Los Alamos Scientific Lab., N. Mex.). June 1967. Contract W-7405-eng-36. 18p. Dep. CFSTI.

For maximum performance, an all-sky photometer should have a large light-collection area and a narrow spectral passband; however, for a given size of photometer, these parameters cannot be optimized simultaneously. Three compromise lens designs are evaluated: LASL-2, a 0.43-in.-focal length, f/2.8, 160°-field-of-view lens for use with a 2-in.-diam. photomultiplier tube; and, for use with 5-in.-diam. photomultiplier tubes, LASL-5, a 2.1-in.-focal-length, f/4.0, 120°-field-of-view lens; and EG&G-5, a lens with a nominal 120° field of view, which can be used with or without an ND2 filter covering the central part of the first element. The effective on-axis entrance-pupil areas and the relative response curves as a function of wavelength and incidence angle were measured, and the results are reported. (auth)

42849 (NYO-2873-22) WATER VAPOR PRESSURES OF EQUIMOLAR $LiNO_3$-KNO_3 CONTAINING 0.2-1.0 MOLES OF WATER PER MOLE OF NITRATE AT 119°C. Tripp, Terrance; Braunstein, Jerry (Maine Univ., Orono. Dept. of Chemistry). Mar. 31, 1967. Contract AT(30-1)-2873. 4p. (CONF-670904-1). Dep. CFSTI.

From 154th National Meeting of the American Chemical Society, Chicago, Ill.

The vapor pressures were measured by a differential transpiration method with the reference liquid (pure water) maintained at a lower temperature (64.6°C) than the temperature of the solution. For the equimolar $LiNO_3 + KNO_3$ system the vapor pressure was found to be a linear function of the mole ratio of water to a water concentration as high as $R_H = 1.00$, where R_H is ratio of moles of water per mole of nitrate. Data are presented in a table. (M.C.G.)

42850 (ORNL-TM-1968) SUBROUTINE LAPINV FOR NUMERICAL INVERSION OF THE LAPLACE TRANSFORM. May, R. D. (Oak Ridge National Lab., Tenn.). Sept. 1967. Contract W-7405-eng-26. 26p. Dep. CFSTI.

The subroutine LAPINV computes the inverse Laplace transform of a function whose values are known on a set of equally spaced real points. The method of Legendre polynomial approximation employed and the use of this subroutine are described in this memorandum. A few general remarks on the problem of numerical inversion of the Laplace transform are also included. (auth)

42851 (ORNL-TM-1977) EXACT EXPRESSIONS FOR THE COVARIANCES BETWEEN PRODUCTS OF RANDOM VARIABLES. Wilkinson, John W. (Oak Ridge National Lab., Tenn.). Sept. 1967. Contract W-7405-eng-26. 13p. Dep. CFSTI.

In evaluating the variances of sums of products of random variables one needs the variances of products and the covariances between products of random variables. Exact formulas are developed for these variances and covariances for products of k random variables. These expressions are compared with the usual approximate formulas. (auth)

42852 (ORO-2572-10) DIRECT TECHNIQUE FOR IMPROVING A MATRIX INVERSE. Sitton, Gary A. (Rice Univ., Houston, Tex. Dept. of Electrical Engineering). Aug. 1966. Contract AT(40-1)-2572. 17p. Dep. CFSTI.

A method is shown which transforms the problem of inverting an ill-conditioned matrix accurately to one of inverting a diagonally dominant matrix accurately. An error analysis is outlined and the method is compared in theory and in result with the commonly used iterative methods. This direct method is demonstrated to be the limiting case of an nth order iterative approach as $n \to \infty$. An example is given which shows the advantages of the direct method under very poor conditions. The unreliability of the convergence of the iterative technique due to computational errors is pointed out. (auth)

42853 (RFP-873) STATUS OF MICROWAVE INTERFEROMETRY. Green, H. S. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Dec. 1966. Contract AT(29-1)-1106. 19p. (CONF-670901-1). Dep. CFSTI.

From CIRP International Conference on Manufacturing Technology, Ann Arbor, Mich.

The design of a microwave interferometer is presented, and areas in microwave interferometry that need further development are outlined. The microwave interferometer consists of a radio-frequency signal source, phase comparator, transmitting and receiving antenna, a reference path, and a micrometer-driven phase shifter. (W.H.K.)

42854 (SC-DC-67-1812) A TECHNIQUE FOR PREDICTING NONLINEAR WIND COMPENSATION OF BALLISTIC ROCKET SYSTEMS. Wilson, G. G. (Sandia Corp., Albuquerque, N. Mex.). May 1967. Contract AT(29-1)-789. 9p. (CONF-671004-1). Dep. CFSTI.

From Conference on Unguided Rocket Ballistics Meteorology, Las Cruces, N. Mex.

Techniques for computing rocket launcher corrections in both azimuth and elevation angle are described in an effort to account for many of the nonlinear correction characteristics. (M.C.G.)

42855 (SC-RR-66-2601) GENERALIZED RATIONAL FUNCTION LEAST-SQUARES FITTING TECHNIQUE. Biggs, Frank (Sandia Corp., Albuquerque, N. Mex.). Aug. 1967. Contract AT(29-1)-789. 29p. Dep. CFSTI.

A technique is developed and illustrated that leads to an approximating function consisting of one linear combination of functions divided by another. An option provides the capability of fitting in adjacent intervals, yet requiring continuity of the approximation across the boundaries between the intervals. A capability is also provided to prespecify asymptotic limits for the approximation. (auth)

42856 (SC-RR-67-568) SHORTED GUARD-RING QUARTZ GAGE. Jones, G. A. (Sandia Corp., Albuquerque, N. Mex.). Aug. 1967. Contract AT(29-1)-789. 10p. Dep. CFSTI.

This report presents experimental results which show that construction of Sandia's guard-ring-type quartz gage can be considerably simplified without producing any significant change in the response of the gage to shock stresses. In addition to

effecting a saving in space, the new construction permits a tighter coaxial circuit geometry which makes the gage more immune to interference from extraneous electrical signals. (auth)

42857 (SCL-DC-67-83) BLAST TESTING OF AERODYNAMICS STRUCTURES USING EXPLOSIVE DRIVEN SHOCK TUBES. Ashurst, W. T.; Schultz, R. H.; Stoller, H. M.; Blackwell, A. N. (Sandia Corp., Albuquerque, N. Mex.). Aug. 1967. Contract AT(29-1)-789. 48p. (CONF-670712-3). Dep. CFSTI.

From Conference on Military Application of Blast Simulators, Alberta, Canada.

Characteristics of loads produced on stationary structures in shock tubes are defined. Sandia developed explosive-driven shock tube facilities for blast simulation on aerodynamic structures are described including the expendable Thunderwell which uses detonation products as the primary working fluid and the reusable Thunderpipes which can use either concentrated or distributed solid charges. The one-dimensional Lagrangian hydrodynamic computer codes KO and WONDY were used to calculate flow environments and reduce test program requirements. Aerodynamic techniques for transient flow environments and a two step method for providing structural forcing functions for test items were used. Instrumentation techniques developed and problems encountered for blast testing are described. (F.S.)

42858 (SCL-DR-67-62) MAGNETIC CHRONOGRAPH TECHNIQUE FOR EVALUATING ACTUATORS. Tallerico, L. N. (Sandia Corp., Livermore, Calif.). Sept. 1967. Contract AT(29-1)-789. 34p. Dep. CFSTI.

A method of evaluating the energy output of an explosive actuator utilizing a magnetic chronograph is described. The method can also be used to evaluate design parameters in explosive actuated valves. (auth)

42859 (SU-326P12-8) INDUCTION EFFECTS IN EPR SIGNAL I IN ALGAE. Weaver, Ellen C. (Stanford Univ., Calif. Biophysics Lab.). Aug. 1, 1967. Contract AT(04-3)-326-12. 10p. (CONF-670816-1). Dep. CFSTI.

From Conference on Comparative Biochemistry and Biophysics of Photosynthesis, Hakone, Japan.

The kinetics of the appearance of EPR Signal I in whole cells parallel those for the oxidation of P_{700} and cytochrome. Electron parametric resonance spectroscopy of wild type algae was found to allow the study of the photoreactive center I without interference from overlapping pigments, since the detecting microwave radiation does not itself affect any photosynthesis processes. (auth)

42860 (TID-24021) A RAPID FUNCTION EVALUATOR. Report No. 67-14. Potash, Hanan (California Univ., Los Angeles. Dept. of Engineering). May 1967. Contract AT(11-1)-Gen-10. 112p. Dep. CFSTI.

Thesis.

This study describes a special purpose machine designed for calculation of ln x and e^x and incorporating a number of unique design aspects of general interest including restructurability, generality of building blocks suitable for integrated circuit fabrication, and capability for use as extension of a general purpose computer under operating systems control. (auth)

42861 (TID-24041) PUBLICATIONS OF LASL RESEARCH, 1966. (Los Alamos Scientific Lab., N. Mex.). Sept. 1967. 138p. Dep. CFSTI.

A bibliography is presented which includes Los Alamos Scientific Laboratory reports, papers released as non Los Alamos reports, journal articles, books, chapters of books, conference papers whether published separately or as a part of conference proceedings issued as books or reports, papers published in congressional hearings, theses, and U. S. Patents. Author and report number indexes are included. A tabulation of papers by type of publication is presented in the appendix. (B.G.D.)

42862 (UCRL-50274) THE INTERACTION OF COPPER WITH RAT LIVER MITOCHONDRIA. I. GENERAL FEATURES. Grabske, Robert J. (California Univ., Livermore. Lawrence Radiation Lab.). June 1, 1967. Contract W-7405-eng-48. 25p. Dep. CFSTI.

The effects of Cu^{2+} on respiring rat liver mitochondria were investigated in two types of incubation media. Both media were 8.0 mM succinate, 2.0 mM inorganic phosphate, and 20 mM Tris. In addition, one medium was 80 mM KCl and the other 0.25 M sucrose. In the KCl medium, the mitochondria responded to copper (0.15 mM) by a burst of respiration followed by a complete inhibition of respiration, extensive swelling, and internal disintegration. In the sucrose medium, the mitochondria responded to the same amount of copper by an extended respiratory burst followed by a return to the respiratory rate before the copper was added, minimal swelling, and no detectable internal disruption. In the sucrose medium, copper acted as an uncoupler of oxidative phosphorylation with an effectiveness one-tenth that of DNP. The mitochondrial swelling observed in the KCl medium was independent of the presence of an energy source, inorganic phosphate, K^+, Cl^- and metabolic inhibitors. The Cu^{2+}-induced swelling, but not the respiratory burst, was delayed by the presence of two sulfhydryl reagents, indicating that the binding of Cu^{2+} at the sulfhydryl groups may be involved in the swelling response. The two responses of the mitochondria to Cu^{2+}, i.e., swelling and uncoupling, appear not to be directly related and probably involve different binding sites. The extent of copper binding to the mitochondria as well as the rate of binding was determined. The mitochondria bound 40×10^{-9} moles of copper per mg of protein when exposed to 0.15 mM Cu^{2+}. The uptake of copper came to a steady state within one minute. (auth)

42863 (UCRL-70485) PIEZOELECTRIC EFFECT IN SHOCKED SUCROSE. Hearst, J. R.; Royce, E. B. (California Univ., Livermore. Lawrence Radiation Lab.). June 9, 1967. Contract W-7405-eng-48. 7p. Dep. CFSTI.

Slabs cut from sucrose crystals were mounted on 7.5-cm gun targets. The gun was fired and open-circuit voltage recorded in the same manner as in the tourmaline experiments. A plot of charge release vs longitudinal stress component in the aluminum gives a straight line of 0.88×10^{-8} C/cm^2/kbar and a nonzero intercept. The dynamic yield strength Y is tentatively calculated to be 3.3 kbar. (D.L.C.)

42864 (WAPD-TM-659) CANONICAL AND INVOLUTORY TRANSFORMATIONS OF VARIATIONAL PROBLEMS INVOLVING SECOND DERIVATIVES: APPLICATION TO BEAMS AND PLATES. Kaplan, S. (Bettis Atomic Power Lab., Pittsburgh, Pa.). May 1967. Contract AT(11-1)-Gen-14. 54p. Dep. CFSTI.

The canonical and involutory transformations of the calculus of variations are applied to variational problems in which the integrand of the functional involves the second derivative of the argument function. One and two dimensional examples, i.e., the variational problems governing the deflection of beams and plates, are worked out in detail. (auth)

42865 (Y-1582) BASIC ELECTRICAL DISCHARGE MACHINING CHARACTERISTICS AND ASSOCIATED ELECTRODE MATERIALS AND COOLANTS. Alford, D. R. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Sept. 8, 1967. Contract W-7405-eng-26. 42p. Dep. CFSTI.

Electrical discharge machining (EDM) characteristics of some commonly machined materials, such as uranium, aluminum, steel, and tungsten, have been studied and tabulated at the Y-12 Plant. To a lesser extent, the characteristics of magnesium, titanium carbide, tungsten carbide, and Type 304L stainless steel have also been determined. Data obtained from 15 different electrode materials applied on the workpiece materials in various combinations have been arranged to give shop personnel the information necessary to select and design an electrode, estimate the job time, and set up the power supply. (auth)

42866 (Y-KE-249) LASER METROLOGY TECHNIQUES. Whitten, L. G. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Apr. 6, 1967. Contract W-7405-eng-26. 22p. (CONF-670901-2). Dep. CFSTI.

From CIRP International Conference on Manufacturing Technology, Ann Arbor, Mich.

The rapid progress in interferometry which has been experienced over the past decade is reviewed. It is seen that the single-mode laser has become the most significant factor which made this system industrially useful. There are certain disadvantages and common misconceptions concerning the system, and methods of solving the problems relating to its disadvantages are briefly discussed. Examples of usage which are discussed include: a stationary calibration facility, long-range portable calibration equipment, and a system using the laser interferometer for feedback in a tape-controlled system. (auth)

42867 RETROSPECT. Cockcroft, John (Cambridge Univ., Eng.). Nature (London), 215: 1228-9(Sept. 16, 1967).

The late Sir John Cockcroft, in this contribution, reviews the past achievements and indicates the possible future of the United Kingdom Atomic Energy Authority, with particular reference to the production of competitive nuclear power, and with some reference to the activities of fuel element production and processing, the production and sale of radioisotopes and labeled compounds, the development of particle accelerators, industrial applications of radiation, etc. With regard to the future, the setting-up of a ceramics centre and a non-destructive testing centre at Harwell is mentioned, together with an interest in the exploitation of the resources of the oceans. (UK)